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APPENDIX A

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TENNESSEE VALLEY AUTHORITY RESPONSE

TO

ATOMIC ENERGY COMMISSION QUESTION 340.1 (9.2.4)

ALTERNATE SITES

1.0 INTRODUCTION AND SUMMARY

The site selection process for the LMFBR demonstration plant was carried out by TVA. Screening studies were conducted for eleven potential "new" sites and nine potential "hook-on" sites. The screening studies served to narrow the range of potential sites, and led to detailed engineering, environmental, and economic studies for two hook-on alternative sites (John Sevier and Widows Creek) and a new site on the Clinch River.

Selection of a site for the LMFBR demonstration plant was based on siting criteria established by considering the joint TVA-CE proposal, the AEC's request for proposals and other applicable requirements. Site selection criteria were established in recognition of the developmental nature of the LMFBR concept and the urgency for getting the demonstration phase under way. The economic benefits to the Nation from the LMFBR have been shown to be strongly time dependent. Therefore, immediate availability of a site for the demonstration plant was highly desirable. In addition, it had been determined that any potential site must not require unusual design features or special licensing considerations and should permit the construction of a plant that would conform in every respect with applicable environmental standards.

An important consideration in selecting the site was to assure that the demonstration plant would not have an adverse effect on TVA's ability to provide an adequate supply of electricity to the region it serves. While there was no basis to assume that the plant would not be a reliable producer of electric energy, it was not considered to be an integral part of TVA's power system capacity. Additionally, because of the scarcity of suitable new sites for commercial nuclear power plants, preference was given to those sites which were not expected to be used in the near future for commercial generating plants.

TVA's screening studies for selection of candidate hook-on sites are described in Sections 9.2.1-9.2.3 of the CRBRP-ER. These studies resulted in the selection, for detailed study, of John Sevier and Widows Creek as candidate hook-on sites. TVA's initial screening studies of potential new sites for the LMFBR demonstration plant identified eleven potential sites. The eleven sites, considered in the screening studies, and some of the major characteristics of each site are listed in Table 9.2-2 of the CRBRP environmental report. It was concluded from this study that a comparison of site features and environmental factors showed no apparent overall advantage of these sites over the Clinch River site. There were no known physical, engineering, or environmental reasons that would preclude consideration of a new plant at the Clinch River site. However, among the eleven sites considered, only Clinch River satisfied the new site selection criteria: (1) immediate availability, and (2) no use for commercial generation in the near future. Therefore, it was concluded that the Clinch River site was preferable to alternative potential new sites and should be considered for detailed study as a potential site for an entirely new plant.

Subsequently developed information on the eleven new sites confirms the results of TVA's initial screening studies. Further examination of the eleven sites disclosed that four were found to have questionable geologic or seismic characteristics and thus have received only limited examination since the initial siting evaluation of the LMFBR was performed. These sites: Spring Creek, Caney Creek, Buck Hollow, and Lee Valley were found to have less favorable geologic site characteristics and were eliminated from further consideration (see pages

The results of ongoing site studies conducted by TVA for the remaining six sites can be summarized as follows:

1. The Murphy Hill site was added to TVA's inventory of sites in 1971. This site is under consideration as a potential

location for future commercial capacity application, and does not show any apparent environmental, economic, or technical advantages over the Clinch River site (see pages

2. The Blythe Ferry site met the engineering requirements for a power facility, but development of the site would entail more costly access facilities, primarily rail, than the other potential sites. Rail access to the site has been estimated to require approximately 20 miles of new track and 6 bridges. The site is also located adjacent to the Hiwassee Island Wildlife Area, and may present environmental problems of a sensitive nature (see pages

3. The Taylor Bend site was examined extensively by TVA as a potential location for a nuclear facility, but has been eliminated from further study because of the development of a major land use conflict at the site (see pages

4. The Phipps Bend site has been identified by TVA for inclusion on its inventory site program and has subsequently been authorized by the TVA Board of Directors for purchase. This site is under study as a potential location for future capacity additions (see pages

5. The Hartsville site was added to TVA's inventory of sites in 1973. This site has been selected by TVA as the preferred location for the addition of four boiling water reactors scheduled for commercial operation in the 1980-82 period. An application to locate a plant on this site was filed with the AEC in July 1974 (see pages

6. The Rieves Bend site received examination by TVA as an alternate location to the Hartsville site. During the site evaluation studies of the proposed Hartsville plant, a potential water use conflict was identified with the Duck River project. One of the purposes of the Duck River Water Resource Development Project is to provide a water supply for this region. Accordingly, the consumptive use of water required for cooling tower operation possibly could affect one of the purposes of the Project (see pages

In light of the continuing studies conducted by TVA since the initial siting studies of the LMFBR, the site factors resulting from these studies, and the fact that the available sites continue to offer no overall environmental or other advantage when compared to the Clinch River site, it is concluded that the Clinch River site is the preferred candidate site for detailed study, and consideration against the two candidate alternative hook-on sites (John Sevier and Widows Creek).

2.0 SPRING CREEK SITE

2.1 SITE DESCRIPTION

The site is located in Lawrence County, Alabama, on the left bank of the Tennessee River at TRM 283. It is approximately five miles northeast of Courtland, Alabama, on the east side of the Spring Creek Embayment.

The area covered by the site is approximately 1,500 acres, 200 acres of which is already owned by TVA. Presently the site area consists of various agricultural uses and forest lands, as shown in Figure A2.0-1.

2.2 ACCESS FACILITIES

Barge access by water presents no problem at this site.

Approximately six miles of new track will be required to connect the site with the Southern Railroad. Several gorges must be crossed to complete this project.

Approximately two miles of new road and four miles of reconstruction of existing road will be required to connect the site with the nearest existing primary road.

2.3 TRANSMISSION FACILITIES

Two 161-kV lines lying to the south-southwest pass within six miles of the site. One 500-kV lying to the southeast passes within four miles of the site.

2.4 ENGINEERING CHARACTERISTICS

2.4.1 FOUNDATION CONDITIONS

Recent on-site examination indicates the presence of sink holes which indicates possible foundation problems and solution cavities.

2.4.2 SEISMOLOGY

The site lies within the Southern Appalachian Tectonic Province. This area is one of minimum earthquake hazard.

2.4.3 COOLING WATER

It is believed that sufficient cooling water exists at this site.

2.4.4 FLOOD CONDITIONS

The general site grade will be approximately elevation 595. The preliminary maximum possible flood has been estimated at elevation 573.

2.4.5 SITE TOPOGRAPHY

The site lies on rolling terrain adjacent to the Wheeler Reservation. Site elevations vary from approximately 530 to 650 feet.

2.5 POPULATION

The nearest population centers are listed below.

Town	Population	Distance and Direction
Muscle Shoals, AL	6,900	21 miles; west
Athens, AL	14,400	18 miles; northwest
Decatur, AL	38,000	19 miles; southeast
Huntsville, AL	137,800	38 miles; east

2.6 PROXIMITY TO RECREATION AREAS OR WILDLIFE REFUGES

One public boat launching site lies across the embayment to the west of the site. A TVA Public Use Area is planned for the right bank of the embayment immediately south of the site.

2.7 CONCLUSIONS

Due to foundation conditions as described in Section 2.4.1 above, this site has been dropped from further investigation.

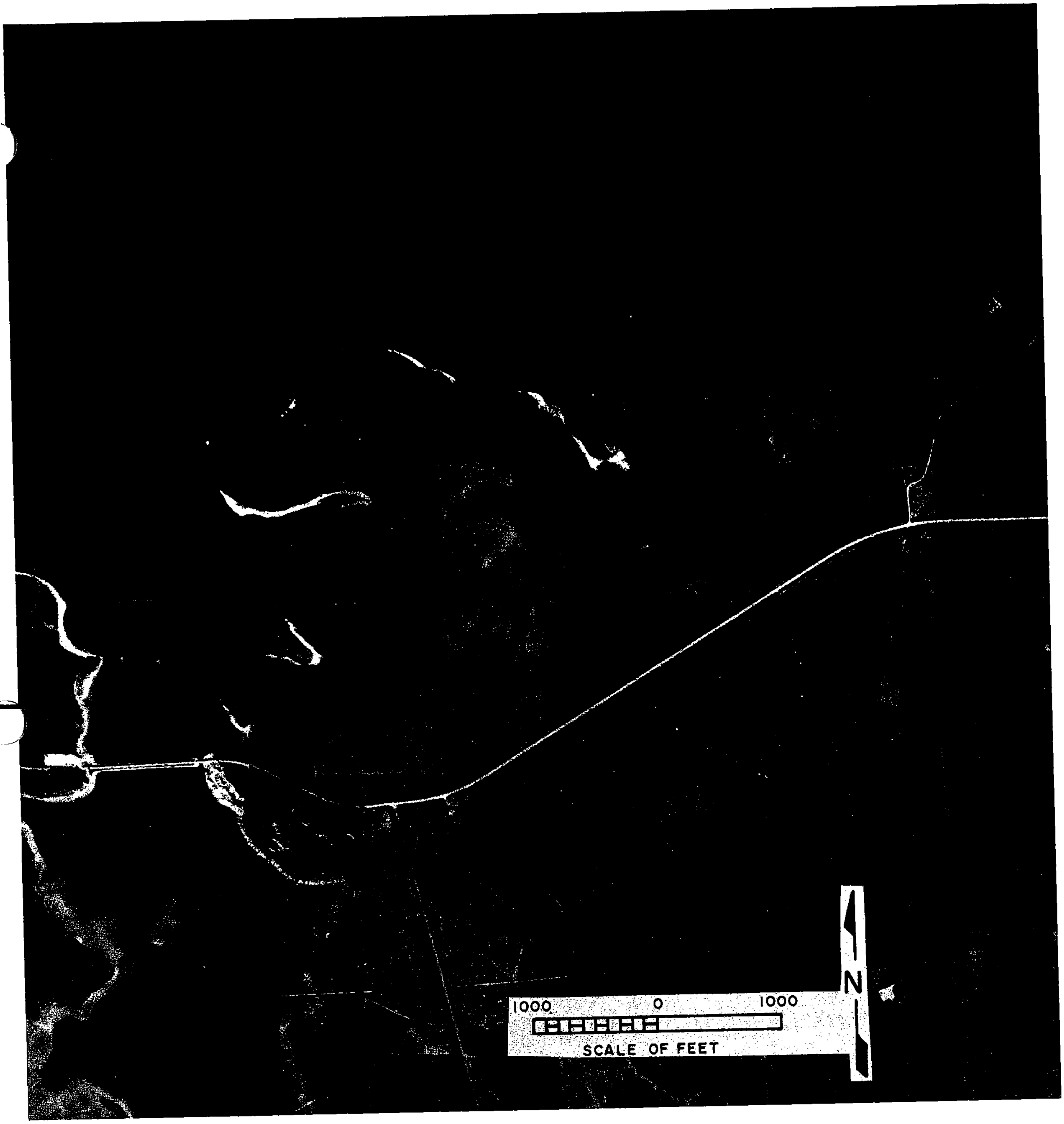

Figure 2.0-1 SPRING CREEK SITE, TENNESSEE RIVER MILE 283L

3.0 MURPHY HILL SITE

3.1 SITE DESCRIPTION

The Murphy Hill site is located on two broad peninsulas which jut out from the southern bank of Guntersville Lake on the Tennessee River at TRM 370, approximately 12.5 miles from Guntersville, Tennessee, as shown in Figure A3.0-1. The property is divided into two physiographic areas totaling 1,235 acres, all of which have been acquired by TVA, see Figure A3.0-2. Terrain adjacent to Guntersville Lake is characterized by low hills gradating into an undulating plain. All of the existing flood plain surrounding Murphy Hill has been inundated by the construction of Guntersville Dam. The site is bound on the southeast by a northeast trending ridge and on the northwest by Guntersville Lake and Murphy Hill from which the site derives its name. To the northeast and southwest the site is bound by embayments of Guntersville Lake. The general elevation of the site area is around elevation 615 and the plant grade is estimated at elevation 621. The elevation of the ridgecrest to the southeast averages 900 feet above sea level, while the highest point on Murphy Hill is slightly over elevation 680.

3.2 ACCESS FACILITIES

Highway access would require 16 miles of road improvement from the site to U.S. Highway 431.

Railroad access would consist of building 16.5 miles of new track, with an embayment crossing, to the existing L&H lines.

Barge facilities are feasible at this site.

An aerial photograph of this site with a 4,000-foot exclusion radius is shown in Figure A3.0-3.

3.3 ENGINEERING CHARACTERISTICS

3.3.1 SEISMOLOGY

The Murphy Hill site lies wholly within the Southern Appalachian Tectonic Province. In this province, which has experienced moderate seismic activity in the past, the maximum earthquake that has occurred in the province is assumed for design purposes to recur at the site. For this site, the maximum earthquake would be the May 31, 1897, quake in Giles County, Virginia, which had a reported epicentral intensity of VIII on the Modified Mercalli scale.

This area is one of minimum earthquake hazard, not only because it is structurally stable itself, but also because of its distance from known areas of past earthquake activity. The area has been the site of epicenters of a few small earthquakes which were not related to known faults and, the seismic origin of some of these shocks is questionable. Similar small quakes are to be expected in the future, but the effects of such quakes would be less at any of the proposed sites than the attenuated effects from major earthquakes occurring on the Reelfoot Tectonic Structure to the west.

3.3.2 HYDROLOGY

The Murphy Hill site is located on Guntersville Reservoir at Tennessee River mile (TRM) 369L. The Tennessee River has a drainage area of 40,910 square miles at its mouth and approximately 23,780 square miles above the proposed plant site. Flows past the site are controlled by the upstream reservoir regulation. Mean daily streamflow at the proposed Murphy Hill site is 39,360 cfs. The natural 7-day, 10-year low flow, used by the State of Alabama in applying the water quality criteria to unregulated streams, is 6,250 cfs. For regulated streams the instantaneous minimum flow is used. The minimum instantaneous flow of record applicable at Murphy Hill is 0 cfs.

Preliminary hydrologic investigations have been made to determine the maximum flood elevations that could be expected for the candidate site. These elevations take into consideration wind wave additives and allowances for possible seismic failure of upstream dams. At Murphy Hill, probable flood elevation is 618. The estimated plant grade is 621.

3.3.2.1 GROUNDWATER

The Murphy Hill site is underlain by the Knox Dolomite in the northwestern part and by the Chickamauga Limestone in the southeastern part. Water occurs in openings formed along fractures and bedding planes, some of which are solutionally enlarged, especially in the Knox Dolomite which is a major water-bearing formation.

Groundwater occurs under unconfined (water table) conditions and is recharged by local precipitation. Based on measurements made in June 1971 in seven exploration holes, depth to the water table ranges between 8 and 16 feet and averages 12 feet. Discharge is to Guntersville Lake.

3.3.3 CLIMATOLOGY

In summarizing the general climatological features of the Murphy Hill site area, the representative temperature data from the Scottsboro, Alabama, Cooperative Observer's Station show a mean annual temperature of 59.2 degrees F with the mean monthly temperature ranging from 38.1 degrees F in January to 77.6 degrees F in July. The highest temperature for the period is 109 degrees F in July and the lowest is -16 degrees F in February, resulting in an extreme annual range of 125 degrees F.

Precipitation data collected for Scottsboro, Alabama, by the TVA Hydraulic Data Branch show the greater precipitation amounts occur in December-April and in July and the least in October. The extreme monthly maximum rainfall is 13.80 inches in January and the maximum 24-hour rainfall is 5.81 inches in December.

Data from the Scottsboro, Alabama, Cooperative Observer's Station show that snowfall occurs mostly during the period December through February with an average annual total of 2.8 inches. Reasonably representative data from the Huntsville locality show a maximum 24-hour snowfall of 17.1 inches in December 1963.

The National Weather Service data from Chattanooga indicate that heavy fogs (visibility equal to or less than one-fourth mile) occur about 36 days annually with a maximum monthly frequency of six days in October, and a minimum of two days each month in February through July. At the Huntsville Airport during the six years ending with 1973, the annual frequency of heavy fog was 20 days. Although Huntsville is closer to the Murphy Hill site, the major terrain features (pronounced valley-ridge) in the Chattanooga locality are present in the site area, but not at Huntsville. Thus, heavy fog probably occurs on about 30 days annually in the Murphy Hill site area.

Annual and monthly relative humidity values based on a six-year period (1968-1973) of data collected at the Huntsville National Weather Service Station show an average annual relative humidity of 72.6 percent with the average monthly range from 66.8 percent in April to 76.5 percent in September. The six-hour diurnal distribution of the monthly average shows that the highest relative humidities occur at 0600 central standard time (CST) in July, August and September with respective values of 89, 89 and 90 percent. The lowest monthly average is the April 1200 CST value of 54 percent.

3.3.3.1 SEVERE WEATHER

Severe wind storms may occur several times a year. Records show 63 mph and 82 mph, respectively, for the fastest mile of wind speed recorded in the Huntsville locality and at the Chattanooga Airport. High winds may also accompany thunderstorms, which occur about 57 times a year with a maximum in July.

3.3.3.2 METEOROLOGY (DISPERSION CHARACTERISTICS)

Evaluation of dispersion characteristics for the Murphy Hill site is based on wind direction, wind speed and stability data from the Bellefonte Nuclear Plant site station for April 1973 - March 1974. The Murphy Hill site lies approximately 15 air miles southwest of the Bellefonte site.

The Murphy Hill plant site is located about 12 miles northeast of Guntersville, Alabama. It lies on the flat flood plain, about 615 feet MSL, on the southeast bank of the Tennessee River (Guntersville Reservoir) which flows southwestward through the region. About theee miles northeast of the plant site lies a ridge (1,100 feet MSL) paralleling the river. About 1.2 miles southeast lies a lower ridge, aligned northeast-southwest and rising to about 800 feet MSL. About 2.5 miles southeast of the plant site lies the Sand Mountain escarpment rising to about 1,100 feet MSL.

Vertical temperature gradient measurements between 33 and 130 feet aboveground at the Bellefonte Nuclear Plant site indicate surface-based inversions occurred about 48 percent of the total hours for the period April 1973 - March 1974. A study of the occurrence of atmospheric stagnation cases, or widespread stable atmospheric conditions, lasting seven or more days shows that four to six such stagnation episodes could be expected annually in the Bellefonte-Murphy Hill site areas and would likely occur in the fall, particularly in October.

Wind measurements at 33 feet aboveground at the Bellefonte Nuclear Plant site meteorological facility from April 1, 1973 - March 31, 1974, are used to describe the expected local wind patterns in the Murphy Hill site area. These wind patterns can be considered reasonably representative because of the proximity of the Bellefonte and Murphy Hill sites and the probable absence of appreciable terrain interference of 33-foot wind patterns. The Bellefonte data indicate that the wind predominates from the northeast with secondary maxima distributed among south-southwest, southwest and south. The data also show about 20 percent of the wind speed within the 0.6-1.4 mph range, 26 percent within the 1.5-3.4 mph range and 18 percent within the 3.5-5.4 mph range. About 9 percent of the data show calm conditions at the 33-foot level.

Atmospheric stability conditions at the Murphy Hill site are estimated from representative wind measurements at 33 feet aboveground and representative temperature measurements at 33 and 130 feet aboveground at the Bellefonte meteorological facility. The data show that the Pasquill stability classes E, F and G occurred about 66 percent of the time. The most critical class, G, occurred about 10 percent of the time. The least stable classes A, B and C, occurred about 15 percent of the time, while the neutral class, D, occurred about 19 percent of the time.

The most critical atmospheric dispersion condition, class G, 0.6-1.4 mph, occurred 4.11 percent of the time with an additional 2.76 percent calm. Classes E and F had respective frequencies for the 0.6-1.4 mph and calm conditions of 6.16, 1.85, 6.34 and 2.99 percent.

3.4 POPULATION

Of an estimated 9,653 people within 10 miles of the Murphy Hill site, Scottsboro (population 9,324 in 1970) is the only community which has a population greater than 1,000.

Within 50 miles of the site there are an estimated 914,361 people. Two major urban concentrations are included within this 50-mile radius.

Huntsville, located between the 20-mile and 40-mile radii in the northwest and west-northwest sections, contained a population of 139,282 in 1970. The Attala, Gadsden, Glencoe and Rainbow City urban concentration located between the 20-mile and 50-mile radii in the south and south-southeast sectors, contained a population of 67,446 in 1970.

Figure A3.0-4 depicts the 1970 population distribution at various distances and directions for the Murphy Hill site.

3.5 ENVIRONMENTAL CHARACTERISTICS

3.5.1 LAND USE

Because of the abundance of water resources the Murphy Hill area has developed as a prime water oriented recreation area. Included are Lake Guntersville State Park, Bucks Pocket State Park, numerous commercial boat docks and reservoirs, as well as many lake-front cottages and homes.

Although no communities of any size are in the immediate vicinity of the site, Marshall County is experiencing substantial population growth.

Future population growth is expected to concentrate in the towns of Albertsville, Arab, Boaz and Guntersville. In recent years, limited industrial activity has begun to develop along the Guntersville shoreline including a large Monsanto plant about five miles downstream on the left bank.

3.5.2 ARCHAEOLOGICAL SIGNIFICANCE

Archaeological investigations at the Murphy Hill site were conducted in 1973 by Carey B. Oakley, Research Associate in Archaeology, Department of Anthropology, University of Alabama, see Appendix I to Section 3.0.

The site survey produced four sites of archaeological significance, three of which may be classified as habitational while one represents a probable mound. Sparcity of the sites was attributed to the relative long distance from the site to the original river bank. In that context only the sites located nearest the river were recommended for further investigations.

Excavation of the mound referred to above was begun in 1974 and during this investigation another mound was discovered. Both of these mounds proved to be significant.

3.5.3 HISTORICAL SIGNIFICANCE

A historic survey of this site reveals three structures whose historical significance is currently being examined. TVA has purchased an old log house--the Culbert House of the 1840 period--located on the plant site near the purchase boundary. The Marshall County Historical Society has shown interest in this house based on its architectural significance. However, the former owner has retained salvage rights to this structure. Discussions are under way among interested local development groups and the owner regarding the possible removal of the house to another site and subsequent use by these groups. The other two properties identified are located off the plant site and separated by a ridge. The first is another log structure of the 1840 period on the Hodge property located approximately one-half mile from the site, and the second, a 1900 period house on the Mays property located almost two miles away. While potential impact on these structures is being examined, no appreciable effect is anticipated. The Alabama Historical Commission has reviewed historical properties in this area and identified no others that might be affected by this project.

3.5.4 RECREATIONAL AREAS

Guntersville Lake shoreland in the vicinity of the Murphy Hill site has moderate to high capability for development of a range of recreation facilities. Existing recreation developments within 10 miles of the site and the 1973 annual visitation to these areas are as follows: (1) two state parks, 406,000 visits; (2) two local parks, 307,000 visits; (3) six reservoir public access areas, 43,000 visits; (4) one wildlife management area, 85,000 visits; (5) six group camps, 129,000 visits; (6) thirteen commercial boat docks, 531,000 visits; and (7) twenty-one seasonal second home areas, 494,000 visits. Use of undeveloped public reservoir land within 10 miles of the plant was estimated at 196,000 visits during 1973, for a total of 2,191,000 visits to all developed and undeveloped recreation areas within 10 miles of the site.

There are no plans for recreational development in the immediate site vicinity by private developers. However, one tract located one mile upstream from the site (TRM 371) has been identified as having suitability for a large commercial recreation complex.

3.6 ECOLOGY

3.6.1 VEGETATION

The study site totals approximately 1,200 acres with one-third open and two-thirds forested. All but the southeastern one-third of the site, which is heavily forested, is a mosaic of cultivated fields, pastures and woodland. At least 63 tree species occur on the site. The most common tree species are loblolly pine, Virginia pine, eastern red cedar, chestnut oak and shagbark hickory.

The apparent major impact of the proposed facility upon the vegetation would be the clearing of existing forest (150-190 acres) for plant purposes.

No rare or endangered plant species or habitats have been identified to date. Location of a plant at Murphy Hill will not have a regional or locally significant impact on vegetation.

3.6.2 WILDLIFE

Because of habitat diversity, a rich fauna exists at Murphy Hill. Of the 123 terrestrial vertebrate species observed at the site, there were 13 species of amphibians, 18 species of reptiles, 67 species of birds and 26 species of mammals. No rare, unique or endangered species were found.

3.6.3 FISHERIES RESOURCE

Based on knowledge of the site and Guntersville Reservoir in general, large numbers of larval fish would probably be entrained at the Murphy Hill site. The proximity of South Sauty Creek embayment (three river miles upstream) would probably increase the entrainment of larval fish, particularly if the discharge from South Sauty moves along the shoreline to the intake structure. This would be additive to the entrainment losses at Bellefonte and Widows Creek Steam Plants. Further information is contained in Appendix II to Section 3.0.

3.7 CONCLUSION

This site is currently held by TVA as an inventory site and is presently being considered for commercial application.

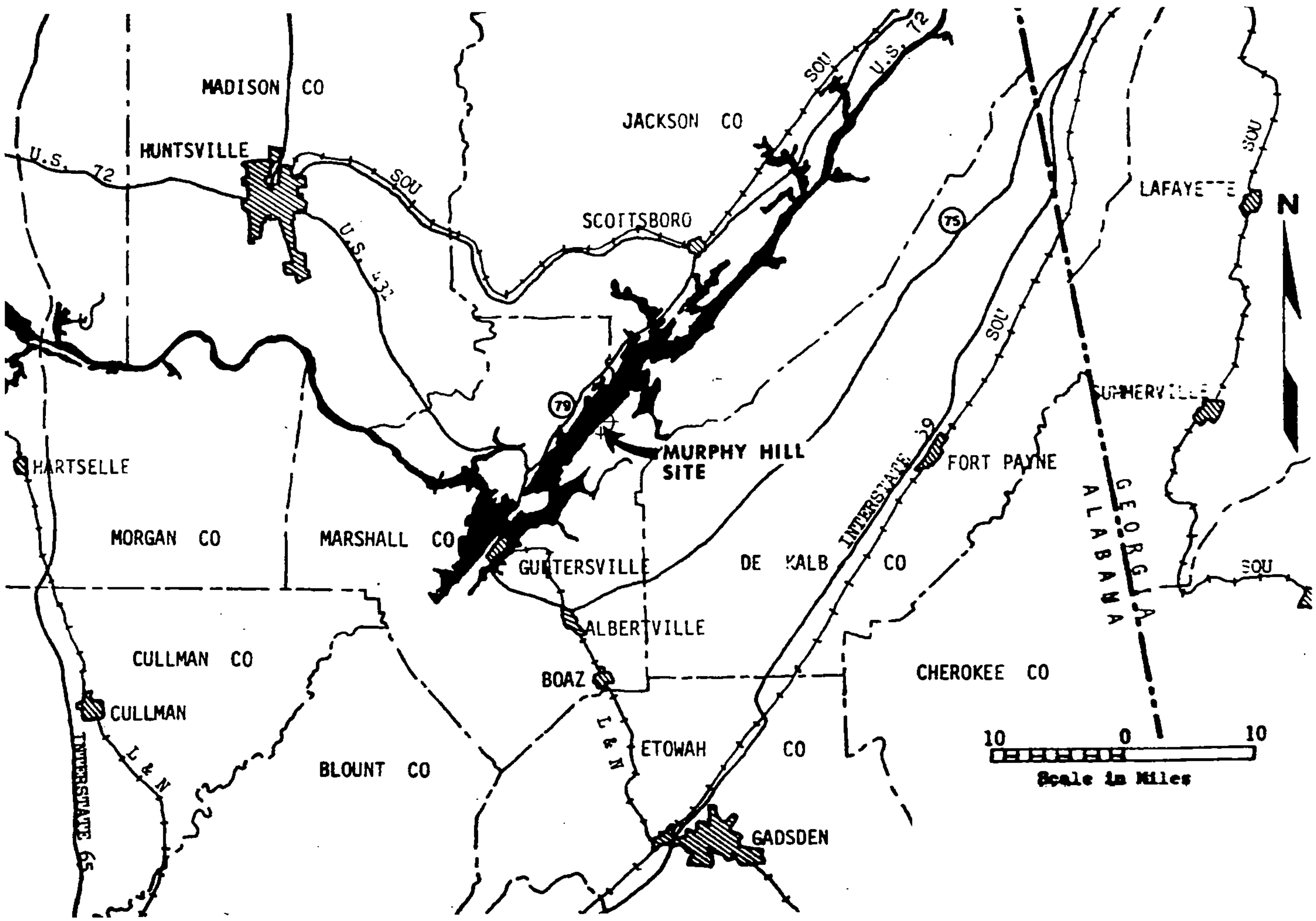

Figure 3.0-1 MURPHY HILL SITE -- LOCALITY MAP

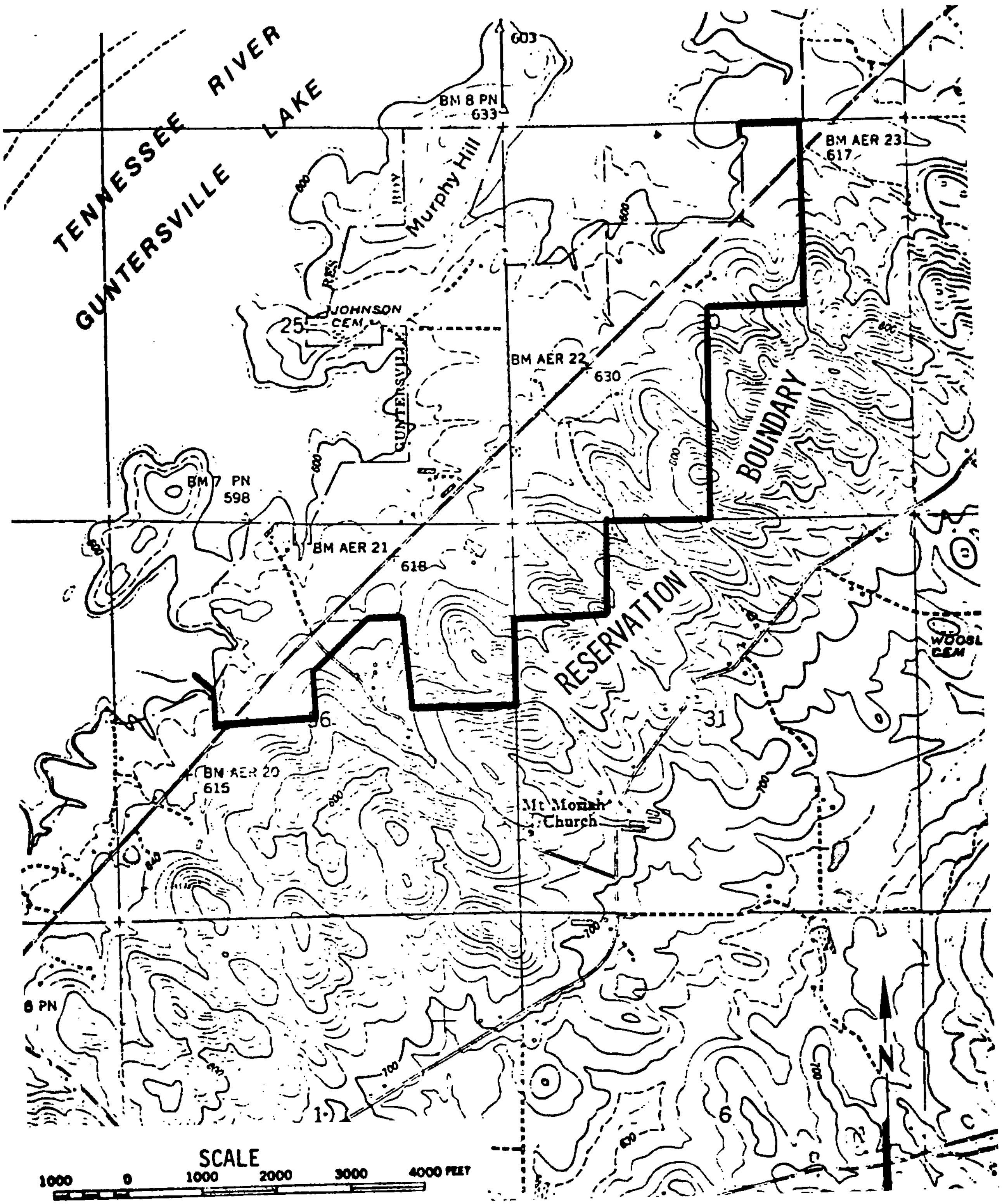

Figure 3.0-2 RESERVATION BOUNDARY MAP -- MURPHY HILL SITE

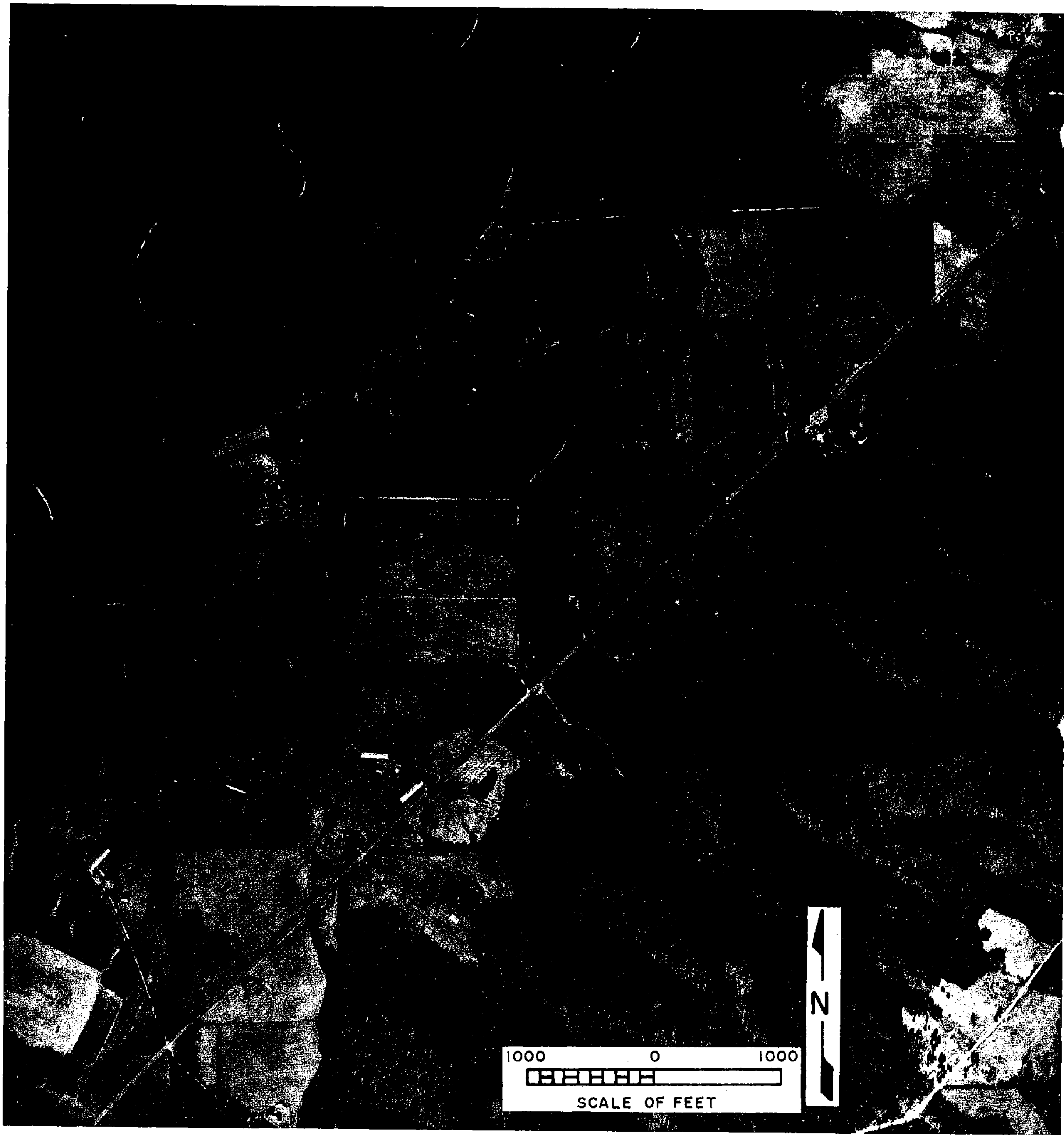

Figure 3.0-3 MURPHY HILL SITE, TENNESSEE RIVER MILE 370L

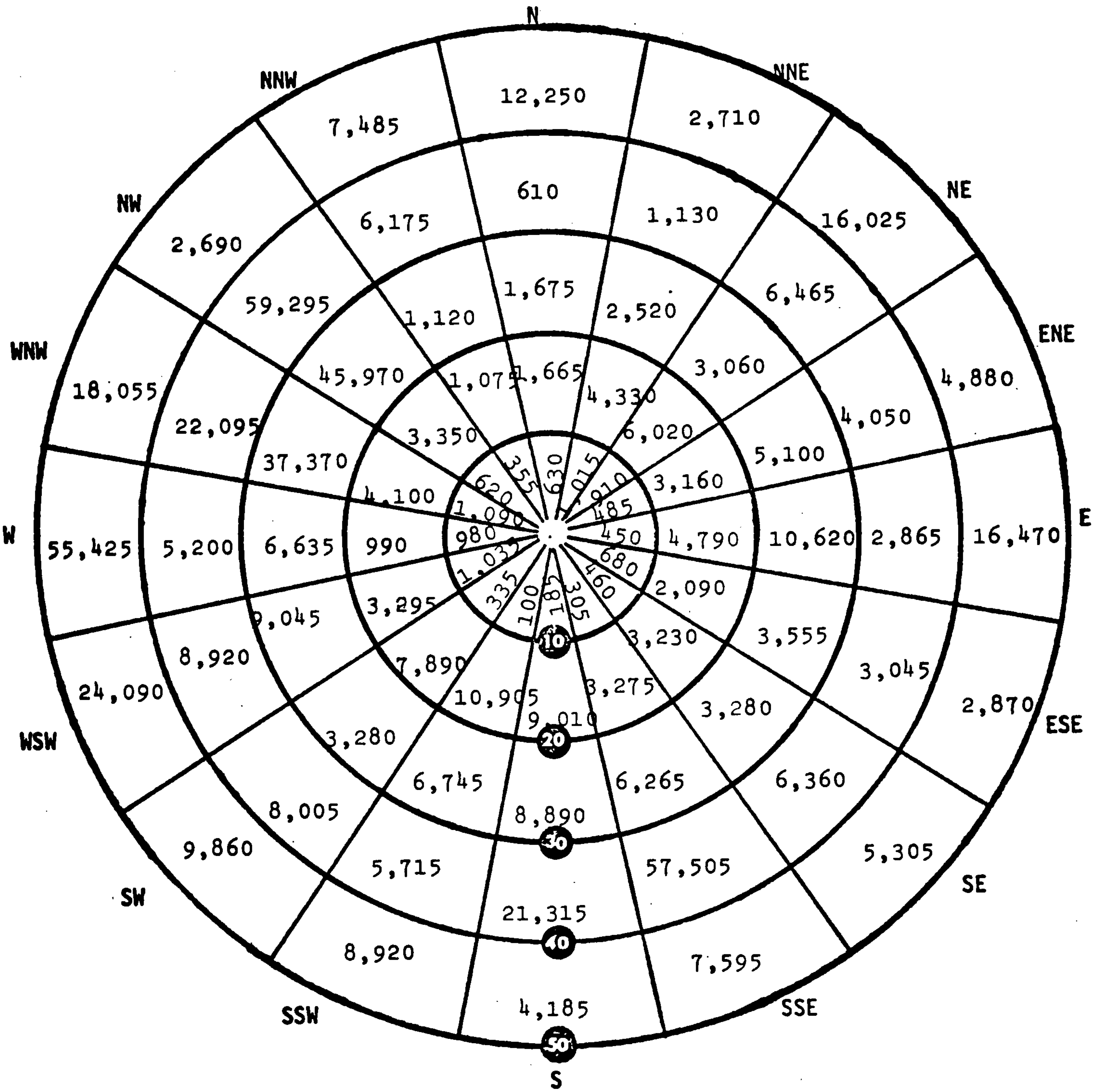

Figure 3.0-4 POPULATION DISTRIBUTION, 1970 -- MURPHY HILL SITE

APPENDIX I TO SECTION 3.0

OF

APPENDIX A

ARCHAEOLOGICAL SURVEY REPORT

MURPHY HILL SITE

AN ARCHAEOLOGICAL SURVEY OF THE MURPHY HILL GENERATING PLANT SITE

By
Carey B. Oakley

In Cooperation With
The Tenneseee Valley Authority
April 15, 1973

AN ARCHAEOLOGICAL SURVEY OF THE MURPHY HILL GENERATING PLANT SITE

At the request of the Tennessee Valley Authority, an archaeological survey was conducted to locate any aboriginal or historical sites that might be disturbed by the construction of the Murphy Hill generating plant facility. Field reconnaissance for this project was completed on April 1, 2, 3, 1973 by Mr. Carey B. Oakley, Research Associate in Archaeology, College of Arts and Sciences, University of Alabama.

Natural Setting

The property selected for the site of the Murphy Hill generating plant facility is located on two broad peninsulas which jut out from the southern bank of Guntersville Lake. The property is divided into two physiographic areas. The terrain adjacent to Guntersville Lake is characterized by low hills gradating into an undulating plain. All of the existing flood plain surrounding Murphy Hill has been inundated by the construction of Guntersville Dam. The area south of Murphy Hill is primarily composed of rough mountain slopes. Soils vary from a sandy loam to a cherty clay. Many areas of Murphy Hill exhibit erosional gullies resulting from extensive row crop cultivation and consequent sheet erosion (Fussell 1959).

Archaeological Background

Much of the prehistory of this area was defined by the extensive archaeological investigations conducted within the Guntersville Reservoir during the 1930's. At that time some 343 sites were located in Jackson and Marshall Counties (Webb 1951). Later excavations in the Sand Mountain area have also contributed a large amount of data concerning the earliest inhabitants utilizing this general area (Clayton 1965). The most recent archaeological survey was conducted on the property selected for the proposed Bellefonte power generating facility (Oakley 1972). The results of these archaeological investigations indicate that this area has been extensively inhabited for eight to ten thousand years.

The Survey

Initial survey procedures consisted of contacting previous landowners and other local residents who may have had knowledge of existing archaeological sites. Most of these people gave vivid descriptions of Indian "burial grounds" located along the original bank of the Tennessee River which now has been inundated by the construction of Guntersville Dam. However, one landowner did provide some information about possible location of archaeological sites on the Murphy Hill property. These areas were checked and a general survey was executed to locate any additional archaeological areas.

Four sites were recorded during this survey:

1Ms 300 (Elevation 460' - 660') - This site was reported by Mr. Sidney T. Johnson, a previous landowner, who had noticed an "unnatural" mound positioned on one of the low knolls which comprises the Murphy Hill landscape. An inspection of the area revealed an oval mound measuring approximately forty feet by fifty-five feet with a height of three to four feet. However, the ruins of an old farm house left some doubt as to the aboriginal nature of the mound. Mr. Johnson assured the investigator that as a boy he had been familiar with the historic dwelling and that there was no connection between the two (Johnson personal communication). One test pit and several soil tests were excavated in order to ascertain the significance of this site. These tests revealed a strata of dark red clay which extended to an average depth of forty-five centimeters. At this point a thin band of wood charcoal was observed scattered over a zone of light red clay. This latter band of clay had an average thickness of ten to fifteen centimeters. Random soil tests around the mound did not produce the scattered charcoal nor the lighter clay band. Although no cultural artifacts were found it is my opinion that this site represents an aboriginal mound typical of the

Copena burial mounds associated with the Woodland period of Northern Alabama. Copena mounds have been reported in the Pickwick (Webb and DeJarnette 1942), Wilson (Fowke 1928), Wheeler (Webb 1939) and Guntersville Reservoirs (Webb and Wilder 1951).

<u>Material Analysis</u>: No material collected.

<u>Cultural Affiliation</u>: Middle Woodland.

1Ms 301 (Elevation ? - 600') - Scattered amounts of lithic debris were found over an area of approximately fifty feet along the existing reservoir shoreline. Although no cultural deposit was detected it is possible that the major portion of this site may have been inundated by Guntersville Lake. Random tests revealed a sterile clay subsoil beneath a thin humus cover.

<u>Material Analysis</u>:
2 biface knives
2 unidentifiable worked stone
5 flakes
3 utilized flakes
2 decortication flakes
2 utilized decortication flakes
7 chunks

<u>Cultural Affiliation</u>: Archaic

1Ms 302 (Elevation 595' - 600') - This small intermittent campsite is located on a low knoll overlooking the shoreline of Guntersville Lake. Sparse amounts of lithic material were recovered from an area of approximately fifty feet by seventy feet. Several test pits revealed a sterile clay strata immediately beneath the plowzone.

Material Analysis: 1 projectile point; 1 stemmed
1 side scraper
1 abrader/hammerstone
3 unidentifiable worked stone
8 flakes
3 utilized flakes
2 decortication flakes
2 utilized decortication flakes
1 chunk

Cultural Affiliation: Late Archaic

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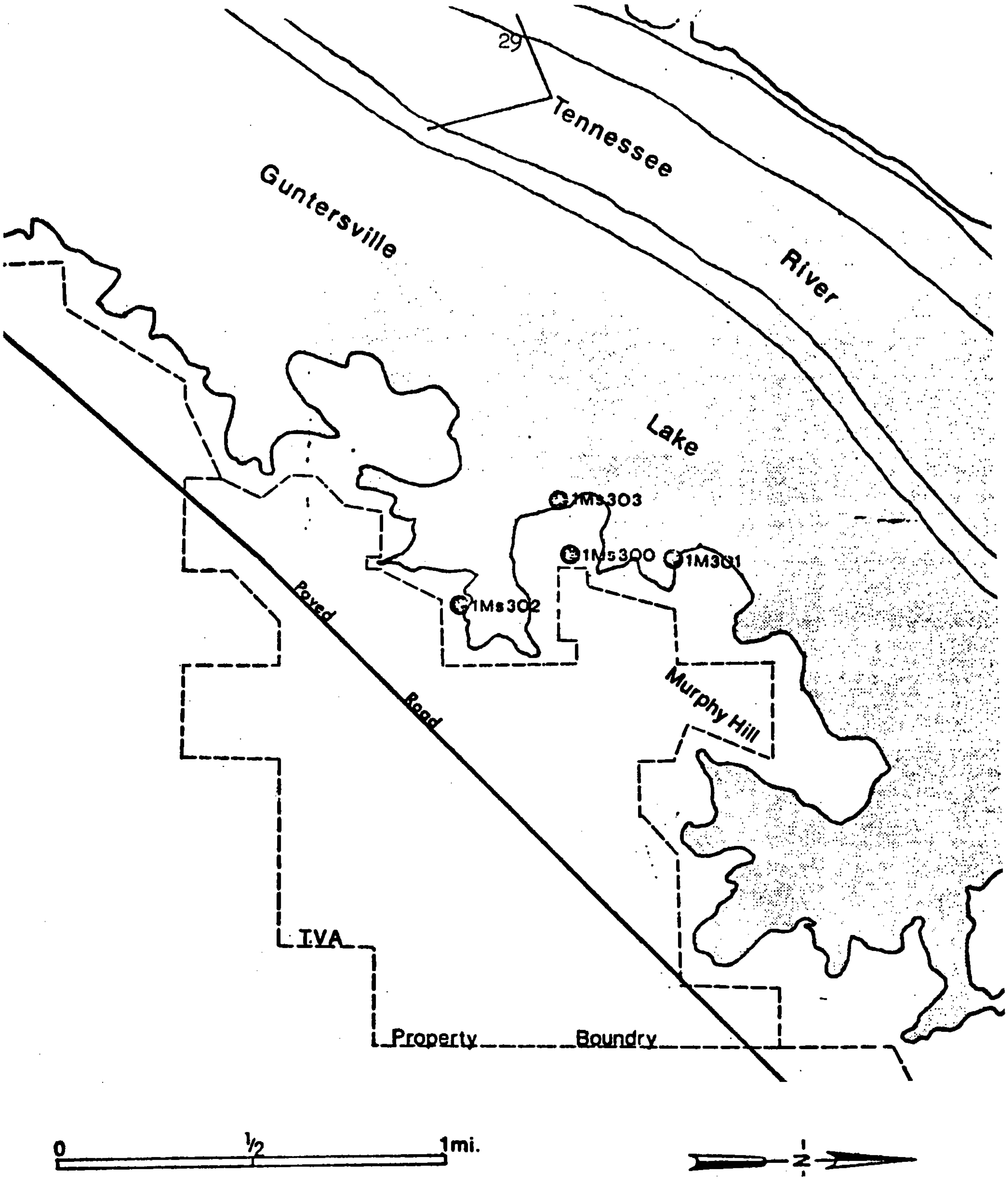

Figure 1 ARCHAEOLOGICAL MAP OF THE MURPHY HILL GENERATING PLANT SITE

APPENDIX II TO SECTION 3.0

OF

APPENDIX A

ECOLOGICAL SURVEY REPORT

MURPHY HILL SITE

Murphy Hill

Vegetation

The Murphy Hill site in Marshall County, Alabama, is characterized by a wide diversity in landscape features and vegetation types. The study site totals approximately 1,200 acres with one-third open and two-thirds forested. The southeastern one-third of the site consists of heavily forested hills having strong local relief, with steep slopes and elevation differences of up to 250 feet with a few hundred yards. Most of the remainder of the area is a mosaic of cultivated fields, pastures, old home sites, as well as understocked, heavily cut-over woodland and some scattered well-stocked forest. A paved county road bisects the site.

An approximate breakdown of general vegetation categories is as follows:

Cover Types	Acres		Percent of Total	
Open land		(370)		(31)
Cultivated	70		6	
Pasture and old fields	300		25	
Forest lands		(830)		(69)
Pine	250		21	
Hardwoods	240		20	
Mixed pine-hardwoods	250		21	
Cedar-hardwoods	70		6	
Cedar	19		1	
		1,200 acres		100 percent

At least 63 tree species occur on the site, which is a large number for an area of this size. The most common tree species are loblolly pine, Virginia pine, shortleaf pine, eastern redcedar, chestnut oak, shumard oak, southern red oak, shagbark hickory, red hickory, and sugarberry. Most of the hardwood stands are dominated by some combination of oaks and hickories. At least 14 oak and five hickory species are present.

The apparent major impact of the proposed facility upon the vegetation would be the clearing of existing forest. Allowing for rerouting of the existing paved road and assuming that practically all of the exclusion area will be cleared or severely impacted, an estimated 150-190 acres of woodland would be affected. The remainder is in pasture, old fields, or cultivated fields (about 40-50 acres of the latter). Most of the forested area involved is in understocked and/or low quality hardwood stands which have been cut over without any regeneration measures. Other than in the fields which have been cultivated for row crops, the dominant land use of the plant location and exclusion area appears to have been for cattle grazing. Much of the hardwood stands show heavy grazing pressure. Most of the slopes have undergone moderate to heavy erosion. In short, due to poor past management practices, most of the forest and pasture likely to be affected is in only fair to poor condition.

No rare or endangered plant species or habitats have been identified in the study area to date. Location of a plant at Murphy Hill will not have a regional or locally significant impact on vegetation.

Wildlife

A rich fauna exists at Murphy Hill and this is directly related to habitat diversity. The site habitat situations range from wetlands along Guntersville Lake to the heads of hardwood coves along the edge of Sand Mountain. A total of 123 species of terrestrial vertebrate were observed on the site in June 1974. This total included 13 species of amphibians, 18 species of reptiles, 67 species of birds, and 26 species of mammals. No rare or endangered species were found. The terrestrial vertebrate fauna of the plant site is typical of that found in the Tennessee River Valley in northeastern Alabama.

The Murphy Hill area is frequented by wintering populations of waterfowl, primarily diving ducks and coots. We do not feel that the area is a unique waterfowl-shorebird area.

Fisheries Resource

No fish sampling has been done at Murphy Hill. The following observations are based on our knowledge of the site and Guntersville Reservoir in general. The Murphy Hill site is located on a shallow overbank area, and the cooling water intake would probably entrain large numbers of larval fish. The proximity of South Sauty Creek embayment (three river miles upstream) would probably increase the entrainment of larval fish, particularly if the discharge from South Sauty moves along the shoreline to the intake structure.

Any loss of larval fish from Guntersville at the Murphy Hill site would be additive to the entrainment losses at Bellefonte and Widows Creek Steam Plant. Murphy Hill is about 22 miles downstream from the Bellefonte site. The State of Alabama presently has serious reservations regarding the location of another nuclear plant on Guntersville Lake. Their concern is apparently largely aquatic. Murphy Hill, therefore, does not appear to be a preferred site from a fisheries standpoint.

4.0 BLYTHE FERRY SITE

4.1 SITE DESCRIPTION

The Blythe Ferry site is located on the east shore of Chickamauga Reservoir at TRM 499 at the confluence of the Hiwassee and Tennesee Rivers approximately six miles from Dayton, Tennessee. Based on a 1,100-acre site acquisition requirement an additional 900 acres of privately owned property would be required, see Figure A4.0-1.

4.2 ACCESS FACILITIES

Highway 60 passes through the plant site. Approximately eight miles of the existing highway would require some maintenance for access to the site.

The nearest existing railroad is the Southern Railway one mile west of Charleston, Tennessee. Approximately 19 miles of railraod would be required for rail access to the plant. Six bridges would be required--five over creeks and one over Interstate Highway 75.

Barge facilities are feasible at this site.

4.3 ENGINEERING CHARACTERISTICS

4.3.1 SEISMOLOGY

The site lies within the Southern Appalachian Seismotectonic Province. The maximum historic earthquake recorded in this province was in Giles County, Virginia, in 1897. This earthquake had an intensity of MM VIII.

4.3.2 HYDROLOGY

At the normal pool elevation of 682.5, the Chickamauga Reservoir is

58.9 miles long and has an area of 35,400 acres with a volume of 628,000 acre-feet. The reservoir has an average width of nearly one mile, and navigation is provided by maintaining a minimum channel depth of 11 feet. Average annual flow at the Chickamauga Dam is 32,800 ft^3/s.

The reservoir is located in a region which derives ground water from precipitation which over the 1931-55 time period had averaged about 48-55 inches per year. Some of the precipitation evaporates, runs off into streams, seeps into the soil to be absorbed or used by vegetation, or seeps downward to become ground water. Movement of ground water at the site would be dependent on the underlying geologic formations.

The site has ready access to the Tennessee River for an adequate supply of water for necessary heat dissipation, auxiliary cooling and other plant needs.

4.3.3 METEOROLOGY

The site is located in the eastern Tennessee portion of the Southern Appalachian Region which is dominated much of the year by the Azores-Bermuda anticyclonic circulation. This circulation is most pronounced in the fall and is accompanied by extended periods of fair weather and wide-spread atmospheric stagnation. In winter the normal circulation pattern becomes diffused over the southeastern states as the eastward moving migratory high and low pressure systems, associated with the midlatitude westerly current, bring alternating cold and warm air masses into the area with resultant changes in regional and local wind direction, wind speed, atmospheric stability, precipitation and other meteorological elements. In summer the migratory systems are less frequent and less intense and the area is under the dominance of the western edge of the Azores-Bermuda anticyclone with a warm moist air influx from the south.

The meteorology of this area provides a rather limited range of atmospheric conditions for transport and dispersion of plant emissions. Conditions are generally most favorable in winter through spring months when migratory pressure systems move alternately through the area, accompanied by moderate to occasionally high wind. Atmospheric dispersion is least favorable in the fall months when extended periods of atmospheric stagnation reach highest frequency.

4.4 POPULATION

The site is located six miles south of the nearest town of Dayton, Tennessee, which has a population of 4,361, and 30 miles northeast of the nearest city with a population over 25,000, Chattanooga, which has a population of 119,082 based on 1970 census data. The population within 5, 10 and 50 miles of the site are 3,691, 16,768 and 683,226, respectively.

4.5 ENVIRONMENTAL CHARACTERISTICS

4.5.1 LAND USE

No development is located near this site. However, the site is just downstream and adjacent to the Hiwassee Island Game Management and Waterfowl Refuge Area which is of major importance to east Tennessee. The compatibility of the site with the continued existence of the wildlife refuge has not been determined. It is judged, however, that impacts of constructing a plant on this site would affect the refuge only during the construction period and no permanent damage to the refuge would result.

4.5.2 RECREATION

Chickamauga Lake is very suitable for recreation and attracted nearly 5.7 million visitors in 1973. It has good sport fishing, clean waters, water contact sports, and attracts about 3,636,000 visits annually.

These visits occur at boat docks and resorts, state and local parks, wildlife areas, public access areas and private residences located along the shoreline.

4.6 ECOLOGY

4.6.1 FISHERIES AND WILDLIFE

Studies of fish and other aquatic life inhabiting Guntersville and Chickamauga Reservoirs indicate that neither of these reservoirs is unique with regard to species populations.

A 1970 Chickamauga Reservoir fish population survey indicated on the basis of numbers 12 percent game fish, 55 percent rough fish and 33 percent forage fish. Bluegill and other sunfish, largemouth bass, spotted bass, white crappie and white bass dominated the game fish. Gizzard and threadfin shad were the dominant forage fish. Two species of buffalo and freshwater drum dominated the rough fish.

The site is in the vicinity of wildlife management area of waterfowl refuge, the Hiwassee Island Game Management and Waterfowl Refuge. This refuge supports the largest concentration of geese in the valley region east of Wheeler Wildlife Refuge and is responsible for an annual hunter harvest of an estimated 2,000 to 5,000 geese per year. Some disturbance of wildlife inhabiting the nearby refuges or waterfowl using the areas seasonally would result during any construction period. The degree of this disruption cannot be predicted. However, after the major construction activities have ceased, the uses of the areas are expected to return to normal and the operation of a plant is not expected to significantly affect the wildlife of the areas.

4.7 CONCLUSION

This site was judged to be of lesser desirability due to possibility of land use conflicts associated with the close proximity of the site to the Hiwassee Island Game Management and Waterfowl Refuge Area. Also it was estimated that extensive costs would be incurred to provide rail access to the site which would require approximately 16 miles of new track and six bridges. In addition Highway 60, which passes through the site and connects with a ferry crossing adjacent to the site, would have to be relocated.

Figure 4.0-1 BLYTHE FERRY SITE, TENNESSEE RIVER MILE 499L

5.0 CANEY CREEK SITE

5.1 SITE DESCRIPTION

The site is located in Roane County, Tennessee, on the Tennessee River at TRM 562R. It is approximately 4.5 air miles southeast of Rockwood, Tennessee and 5.5 miles southwest of Kingston, Tennessee.

The area covered by the site is approximately 1,036 acres of primarily rough, rolling, wooded terrain. A part of the site area has been laid out for a subdivision, but as yet, no houses have been constructed. Since a portion of the land required for the site lies within the Watts Bar Reservoir boundary (65 acres), not all the 1,036 acres will have to be purchased. There are four cemeteries which will have to be relocated, see Figure A5.0-1.

5.2 ACCESS FACILITIES

Barge access is easily available in Watts Bar Lake with minimal dredging.

Approximately six miles of new track will be required to connect the site with the Southern Railroad to the north. The tracks would have to go over some rough and steep terrain, several drainage structures would be required and grade separation structures would be required at U.S. Highways 27 and 70.

Approximately 4.5 miles of road will have to be improved to connect the site to U.S. Highways 27 and 70 to the northeast of the site.

5.3 TRANSMISSION FACILITIES

Two 161-kV transmission lines pass within 4-1/2 miles of the site. One 500-kV transmission line passes six miles southeast of the site.

5.4 ENGINEERING CHARACTERISTICS

5.4.1 FOUNDATION AND SEISMIC CONDITIONS

Based upon a reconnaissance of the site the geologists have determined that there are five faults within 2.5 miles of the site to the northwest. The nearest fault is no more than 0.5 mile away.

5.4.2 COOLING WATER

It is believed that sufficient cooling water exists at this site.

5.4.3 FLOOD CONDITIONS

The general site grade will be approximately elevation 820. The preliminary maximum possible flood has been estimated at elevation 771.

5.4.4 SITE TOPOGRAPHY

The site is located on a peninsula of rough, rolling terrain. Ground surface elevations vary from about 600 feet to around 900 feet at some of the high ground summits in the general area.

5.5 POPULATION

Nearest population centers to the site are Rockwood, Tennessee (population 4,100, 4.5 miles northwest), Kingston, Tennessee (population 4,100, 5.5 miles northeast), Harriman, Tennessee (population 8,700, 7.5 miles northeast).

5.6 PROXIMITY TO RECREATION AREAS OR WILDLIFE REFUGES

Roane County Park is about 1.5 miles northeast of the site. There are public access areas along the eastern edge of the peninsula on which the site is located.

5.7 CONCLUSIONS

Because of questionable foundation and seismic conditions, Section 5.4.1, no further investigations will be made at this site.

Figure 5.0-1 CANEY CREEK SITE, TENNESSEE RIVER MILE 562R

6.0 TAYLOR BEND SITE

6.1 SITE DESCRIPTION

The Taylor Bend site is located in Jefferson County, Tennessee, on the Douglas Reservoir at French Broad River mile 64R, approximately seven miles northwest of Newport, Tennessee.

The site is situated on a large peninsula called Taylor Bend on the Douglas Reservoir and is characterized by gently sloping terrain that increases in elevation from about elevation 1,030 in the eastern portion of the site to approximately elevation 1,100 in the western portion of the site.

The site consists of approximately 1,480 acres (assuming a 4,000-foot exclusion zone) 580 acres of which are under a permanent flowage easement to TVA. However, due to the physical configuration of the site, it is highly probable that acquisition of the entire peninsula would be required since the plant area would block access to the southern portion by land. Under this criteria approximately 3,030 acres would be involved in the purchase 1,650 acres of which are under permanent flowage easements. An aerial photograph of the site is shown in Figure A6.0-1.

6.2 ACCESS FACILITIES

Two major highways are in close proximity to the site, Interstate 40 and U.S. 25E. To gain plant access about two miles of new road would be required to connect the site with U.S. 25E.

The nearest rail facility is Southern Railroad which passes about four miles north of the site. Approximately 4-1/2 miles of new track would be required to connect the site with the nearest rail facilities.

The French Broad River at the Taylor Bend site does not provide barge access. Nearest accessible point by barge is at Knoxville, Tennessee, about 33 air miles west of the site.

6.3 ENGINEERING CHARACTERISTICS

6.3.1 SEISMOLOGY

The Taylor Bend site lies within the Southern Appalachian Province. The largest earthquake known in this province occurred in Giles County, Virginia, on May 31, 1897, with a reported intensity of MM VIII.

6.3.2 GEOLOGY

The Taylor Bend site has been core drilled to determine the underlying geologic structure. At this time 85 holes have been drilled. The results of analyses of these cores show that the foundation rock consists of Sevier shale and that the overburden which would be removed varies in depth from 2 to 72 feet with an average of 35 feet. Foundation treatment of this site would probably be on a limited scale only and a blanket grouting program would not be expected.

6.3.3 HYDROLOGY

French Broad River is the major river in east Tennessee which joins with the Holston River near Knoxville, Tennessee, to form the Tennessee River. The French Broad, which is impounded by TVA's Douglas Dam located at FBRM 32.3, has a drainage area of 5,124 square miles at its mouth. Approximately 4,400 square miles of this drainage area is located above the proposed plant site at river mile 64. Reach of the French Broad River in the vicinity of the plant site is impounded by Douglas Reservoir (Douglas Dam located at mile 32.3) when the reservoir is at normal summer pool elevation of 1,000 feet MSL. On January 1 of each year when Douglas

Reservoir is drawn down to normal minimum pool elevation of 920 feet MSL for flood control purposes, about ten miles of open river will occur between the site and the headwaters of Douglas Reservoir (about FBRM 53). When Douglas Reservoir is at about elevation 960 feet MSL, the headwaters of the reservoir will extend up to the site. Based on the current operating rule curve for Douglas Reservoir, the river in the vicinity of the site would normally be impounded from about mid-March to mid-December of each year. There are two reservoirs in the French Broad River basin upstream from the site which have only minor effects on the regulation of the streamflows at the plant site. These are listed in Table A6.0-1.

6.3.3.1 GROUNDWATER

The Taylor Bend site is located in a belt of Sevier Shale, which locally is a moderately productive aquifer capable of yielding up to 100 gpm to well. Water occurs in the Sevier Shale in openings formed along fractures and bedding planes, some of which have been solutionally enlarged.

Groundwater at the site occurs under unconfined (water table) conditions and is recharged by local precipitation. Water movement is from higher to lower topographic areas and discharge is to French Broad River. Locally, semi-confined conditions cause water levels in a few core holes to rise above land surface. Depths to the zone of saturation normally range from 50 feet in the higher parts of the site area to zero locally in lower areas near drainageways. Mean depth to water, based on measurements in 29 exploration holes in December 1972, is 12 feet.

6.3.3.2 PRESENT WATER SUPPLIES WITHIN A 20-MILE RADIUS

There are presently 11 public and 8 industrial water supplies within a 20-mile radius of the proposed site. The locations of the water supplies are shown in Figure A6.0-2 and are tabulated in Table A6.0-2.

6.3.3.3 WATER QUALITY

Water quality at the site is generally quite good. In the past, large waste discharges by industrial water users, particularly paper mills, textile mills, tanneries, and mining and washing operations, caused a deterioration in certain stream reaches of the French Broad River and its tributaries which, to a limited extent, adversely affected water quality (color and suspended solids) in the vicinity of the proposed site. Extensive improvements in waste treatment are being implemented by the upstream dischargers. These improvements in treatment have resulted in some improvement in the quality of the already high-quality water which occurs in the vicinity of the proposed plant site. However, color levels in the headwaters of Douglas Reservoir would still be expected to be above desirable aesthetic levels.

The annual variations in the water temperature of Douglas Reservoir at Douglas Dam (FBRM 32.3) and at Swann Bridge (FBRM 54.4) for the period from July 1943 through August 1948 are shown in Figures A6.0-3 and A6.0-4, respectively. Although these data are quite old, there are no known changes in thermal discharges or land use in the French Broad drainage area above Douglas Dam that would indicate that these data would not be representative of present temperature conditions of the reservoir. The maximum daily water temperature of 86 degrees F, which occurred during this period was recorded at Swann Bridge (river mile 54.4) in September 1947 and in July 1948. In June 1969, a surface water temperature of 94.6 degrees F was observed at mile 54.0 during a TVA water quality survey. Surface temperatures above 90 degrees F were observed generally over the entire lake during this survey.

6.3.3.4 FLOODING ELEVATIONS

Based on preliminary analysis, the estimated maximum possible flood level at the Taylor Bend site is 1,016 feet MSL. With the application of coincident wind wave runup, an estimated four to six feet would be added. The resulting maximum water levels would be from 1,020 to 1,022 feet MSL. There are no upstream dams which might fail from flood or seismic forces.

6.3.4 METEOROLOGY

A preliminary and subjective appraisal of the expected low-level atmospheric dispersion at Taylor Bend is based on limited meteorological data from an area of minimal familiarity. In assessing the low-level dispersion, joint percentage frequencies of wind direction and wind speed for the stability classes (Pasquill A-G) were developed. These were based on (1) hourly wind data from the John Sevier Steam Plant meteorological facility located 30 miles northeast of the Taylor Bend site, (2) hourly temperature gradient data from the Sequoyah Nuclear Plant meteorological facility and (3) general synoptic conditions from the daily National Weather Service meteorological charts. One year (1972) of hourly wind direction, wind speed and stability values was extrapolated, including modification based on the expected effects of the local valley-ridge terrain. The results of this analysis are presented on Tables A6.0-3 and A6.0-4.

6.4 POPULATION

The site is located in a sparsely populated region. The nearest population center to the site with a total population in excess of 5,000 is Newport, Tennessee, approximately five miles southeast of the site with a 1970 population of 7,300. The 1970 populations within 10, 20, 30, 40 and 50 mile radii were roughly approximated based on 1970 census data and are 29,190, 104,595, 200,310, 464,850, and 796,000, respectively.

6.5 ENVIRONMENTAL CHARACTERISTICS

6.5.1 LAND USE

The predominant existing land use on this site is agriculture. Based on February 1973 and March 1973 aerial photographs of the site, more than one-half of the land is cleared.

Present land use in the vicinity of the site is an intermixing of agriculture, low density housing and industrial uses. The largest industrial developments are the Lowland Plant, a division of American Enka, located approximately nine miles northeast of the site and an industrial park just north of Newport, Tennessee, about five miles southeast of the site. The Lowland Plant is the largest industrial facility in the area and is judged to have a high potential for future expansion. Although other industrial organizations exist within the site area, these are the two most prominent. Further identification of land use within the immediate site vicinity is shown in Figure A6.0-5.

The site area (approximately 500 acres) is currently being developed by Mini Farms, Inc., a recreational land developer. The development known as Lakeland will include a 18-hole golf course, a marina, clubhouse, riding stables and tennis courts surrounded by approximately 2,000 homesites.

6.5.2 ARCHAEOLOGICAL SIGNIFICANCE

TVA has had a surface survey conducted by Dr. Major C. R. McCollough, Mr. Lloyd N. Chapman and Mr. Howard Earnest, Jr., in January of 1973 for the purposes of locating and evaluating archaeological sites and historic features of the site. No surface indications relating to prehistoric human occupation or utilization were found within the central plant area or exclusion zone. A copy of this report is attached as Appendix I to Section 6.0.

6.5.3 HISTORICAL SIGNIFICANCE

There are three historic sites listed in the National Register of Historic Places within 10 miles of the site. The closest one is about five miles from the site.

6.5.4 PROXIMITY TO WILDLIFE REFUGES

There are no wildlife refuges within the immediate vicinity of the site. The nearest refuge identified is approximately 10 miles southwest of the site.

6.5.5 RECREATION

The immediate site area is being developed extensively for recreational use (see land use discussion). This is considered the most significant recreational factor in the site area.

6.6 ECOLOGY

6.6.1 BENTHIC FAUNA SURVEY

Qualitative and quantitative benthic fauna samples were collected at the Taylor Bend site on February 21, 1973. These samples were collected to determine species of aquatic fauna that occur in the area and whether any are endangered.

Thirty genera or families of aquatic organisms representing 13 orders were found in the two inflowing streams at Taylor Bend, see Figure A6.0-6 and Table A6.0-5. Twenty-five genera were collected at Station 1 and fifteen at Station 2. Ten of the same genera occurred in both streams. Station 1 had the greatest biomass with an average of 6.55 g/m^2, while Station 2 had 3.20 g/m^2, as shown in Table A6.0-6.

The species of organisms shown in Table A6.0-5 are usually considered indicators of good water quality. Because of the abundance and wide distribution of the organisms, the present water quality of these streams is good and consequently, none were considered endangered.

6.6.2 VEGETATIONAL SURVEY

A survey was conducted of the vegetational conditions at the Taylor Bend site in October 1972 by Allen C. Skorepa, Department of Botany, University of Tennessee. The results of this survey are described in Appendix II to Section 6.0.

6.6.3 FISH SURVEY

A survey was conducted of the fisheries resources in the Douglas Reservoir during June 1973. The results of this survey are presented in Appendix III to Section 6.0.

6.7 CONCLUSION

The Taylor Bend site appears to meet the basic criteria used to select new generating plant locations and was considered a good potential site. However, the noteable land-use conflicts cited previously were judged to be of over-riding significance and therefore the site was not considered further as a candidate location.

TABLE A6.0-1

DAMS LOCATED UPSTREAM FROM FBRM 64.0

Dam	River	Mile
Walters	Pigeon	38.0
Nolichucky	Nolichucky	46.0

TABLE A6.0-2

WATER SUPPLIES WITHIN 20-MILE RADIUS OF PLANT SITE

Taylor Bend

Water Supply	Approximate Radial Distance From Site (miles)	Estimated Population Served	Average Daily Use (gallons)	Source
Public Supplies				
1. Morristorn*	16	37,541	3,460,000	Holston River, Spring, Wells
2. Jefferson City**	15	6,653	1,140,000	Spring
3. Newport	9	10,122	887,000	Cocke County Utility District
4. Parrottsville School	10	600	15,000	Well and Cocke County Utility District
5. Bulls Gap	18	1,035	68,000	Spring+
6. White Pine	6	1,838	121,000	Wells
7. Dandridge	8	1,688	143,000	Spring and Well
8. Piedmont Elementary School	14	174	4,400	Well
9. Swannsylvania School	7	155	3,900	Well
10. Chestnut Hill School	7	197	4,900	Well
11. Sevierville	17	5,658	500,000	Little Pigeon
Industrial Supplies				
1-I. American Enka Corporation	9		53,000,000	Nolichucky River
2-I. White Pine Stone Company	8		135,000	Long Creek
3-I. A.C. Lawrence Leather Co.	8		350,000	Wells
4-I. Cosby Poultry	14			Well
5-I. Bush Brothers Company	8		1,000,000	Wells
6-I. Cherokee Textile Mills	19		450,000	Little Pigeon River
7-I. Stokely-Van Camp, Inc.	20		180,000	Wells
8-I. Douglas Dam Powerhouse	15		10,500	Spring

*Includes Alpha-Palcott Utility District, Bean Station Utility District, Russellville-Whitesburg Utility District, South Morristown-Witt Utility District.

**Includes New Market Utility District data. Jefferson City has contracted to serve the New Shady Grove Utility District

+Spring is located in Hamblen County.

TABLE A6.0-3

PERCENT OCCURRENCE OF ATMOSPHERIC STABILITY

Pasquill Stability Class	Vertical Temperature Difference	Taylor Bend*
A	$\Delta T \leq -1.9°$ C/100 m	0.68%
B	$-1.9 < \Delta T \leq -1.7°$ C/100 m	2.48%
C	$-1.7 < \Delta T \leq -1.5°$ C/100 m	15.46%
D	$-1.5 < \Delta T \leq -0.5°$ C/100 m	38.07%
E	$-0.5 < \Delta T \leq -1.5°$ C/100 m	26.62%
F	$1.5 < \Delta T \leq 4.0°$ C/100 m	12.51%
G	$\Delta T > 4°$ C/100 m	4.19%
		100.01%

*Extrapolated

TABLE A6.0-4

PERCENT OCCURRENCE OF WIND SPEED*

	Wind Speed (mph)						
Plant Site	Calm	0.6-3.4	3.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5
Taylor Bend	1.87	32.42	42.63	18.01	4.39	0.49	0.19

*Extrapolated from wind speed data from John Sevier Steam Plant meteorological facility, located 30 miles northeast of Taylor Bend. Wind speed sensor 80 feet aboveground.

TABLE A6.0-5

DISTRIBUTION OF AQUATIC MACROINVERTEBRATES IN THE TWO STREAMS SAMPLED, TAYLOR BEND, DOUGLAS RESERVOIR - FEBRUARY 21, 1973

Organism	Station 1	Station 2
Amphipoda		
Gammarus sp.	X	X
Basommatophora		
Physa sp.	X	
Coleoptera		
Psephenus sp.		X
Stenelmis sp.	X	
Decapoda		
Cambarus sp.	X	X
Diptera		
Chironomus sp.		X
Coelotanypus sp.	X	X
Culicoides sp.	X	
Simulium sp.	X	
Tipula sp.	X	X
Ephemeroptera		
Caenis sp.	X	
Centroptilum sp.	X	
Heterocloeon sp.	X	
Stenonema sp.	X	X
Heterodonta		
Sphaerium sp.		X
Isopoda		
Asellus sp.	X	
Lirceus sp.		X
Megaloptera		
Chauliodes sp.	X	X
Odonata		
Calopteryx sp.	X	X
Cordulegaster sp.	X	
Dorocordulia sp.		X
Plecoptera		
Acroneuria sp.	X	X
Capnia sp.	X	
Nemoura sp.	X	
Prosopora		
Lumbriculidae	X	X
Trichoptera		
Cheumatopsyche sp.	X	X
Chimarra sp.	X	
Hydropsyche sp.	X	
Neophylax sp.	X	
Rhyacophila sp.	X	
Total (30 genera or families)	25	15

TABLE A6.0-6

NUMBER AND WET WEIGHTS OF MACROINVERTEBRATES COLLECTED IN EACH SURBER SAMPLE AT TWO STREAMS, TAYLOR BEND, DOUGLAS RESERVOIR

FEBRUARY 21, 1973

	Station 1			Station 2		
	Sample No.					
Organism	1	2	3	1	2	3
Amphipoda						
Gammarus sp.			1	3	2	3
Coleoptera						
Psephenus sp.				3	8	4
Stenelmis sp.		3				
Diptera						
Coelotanypus sp.	3		2		2	4
Culicoides sp.	1					
Simulium sp.	4					
Ephemeroptera						
Caenis sp.	5	17	14			
Heterocloeon sp.		3				
Stenonema sp.			2		1	
Heterodonta						
Sphaerium sp.					1	1
Isopoda						
Lirceus sp.				21	7	5
Megaloptera						
Chauliodes sp.	3	1	1		1	
Plecoptera						
Acroneuria sp.	2	5	4		2	
Capnia sp.			1			
Nemoura sp.			2			
Prosopora						
Lumbriculidae						2
Trichoptera						
Cheumatopsyche sp.	5				1	3
Chimarra sp.	1		2			
Hydropsyche sp.		2				
Neophylax sp.	11	14	4			
Rhyacophila sp.			1			
Total wet biomass of each 0.093-m^2 sample	0.763	0.649	0.413	0.405	0.263	0.223
Average wet biomass at each station (g/m^2)		6.55			3.20	

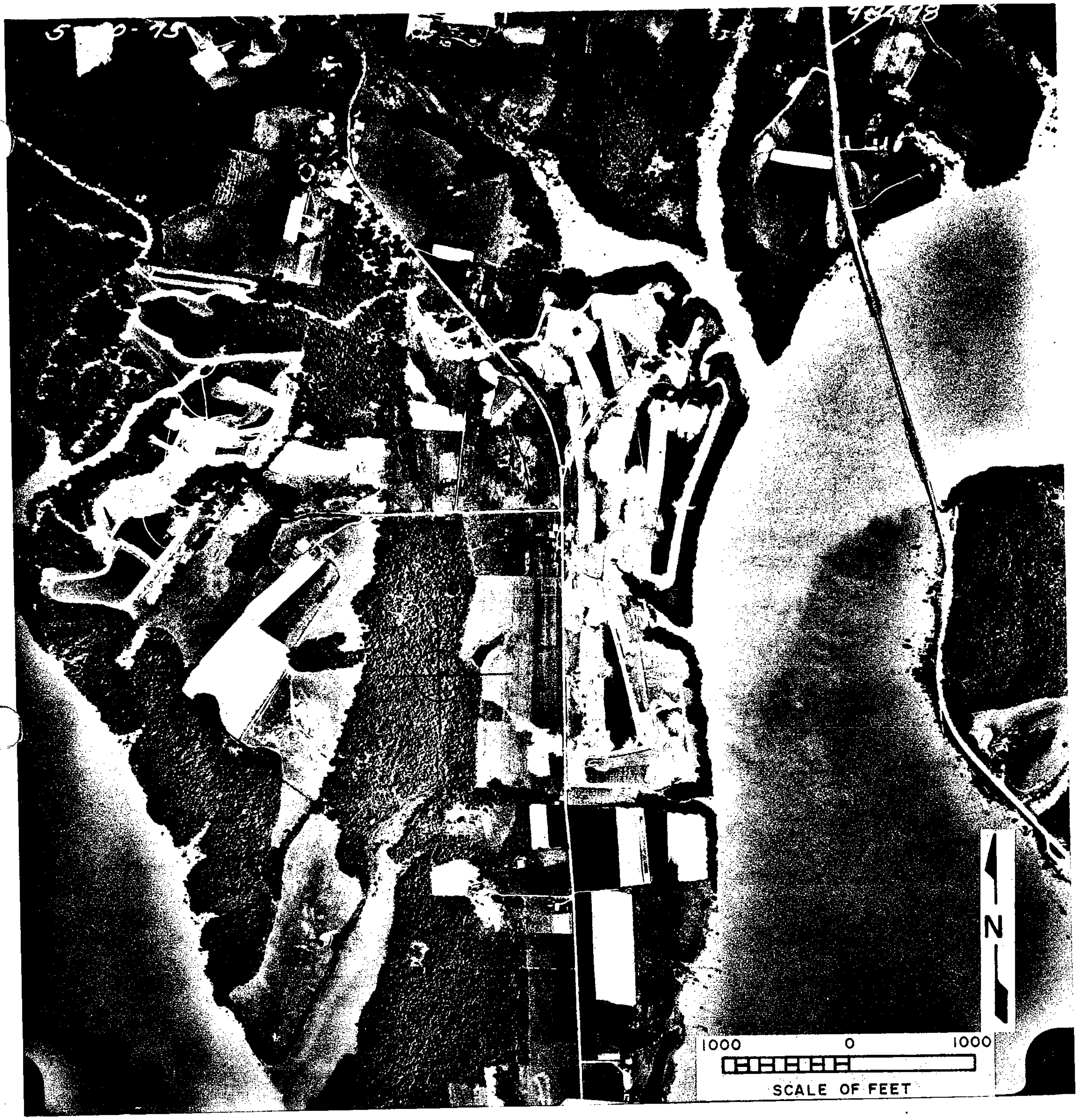

Figure 6.0-1 TAYLOR BEND SITE, FRENCH BROAD RIVER MILE 64R

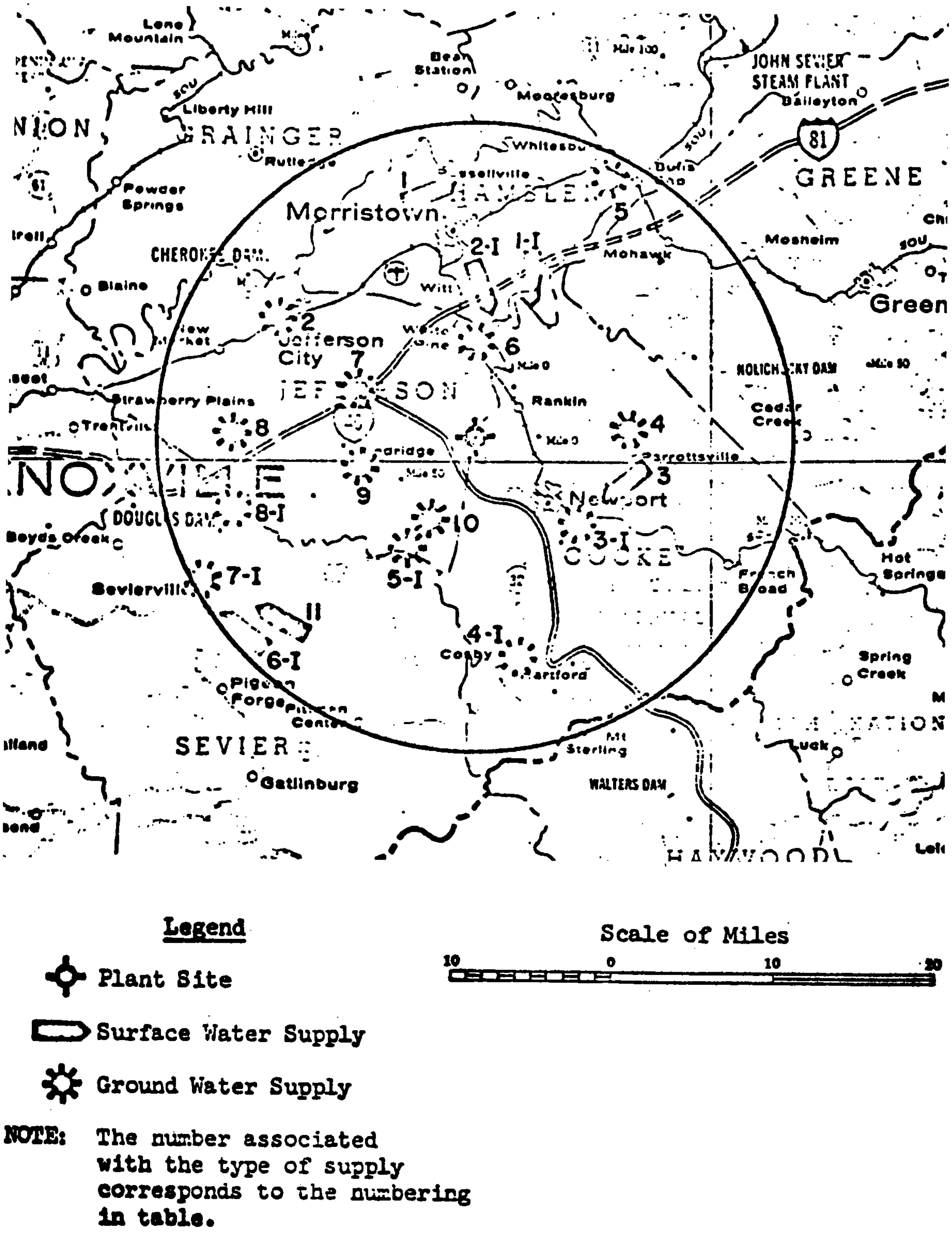

Figure 6.0-2 SURFACE AND GROUNDWATER SUPPLIES WITHIN 20-MILE RADIUS OF THE PLANT SITE

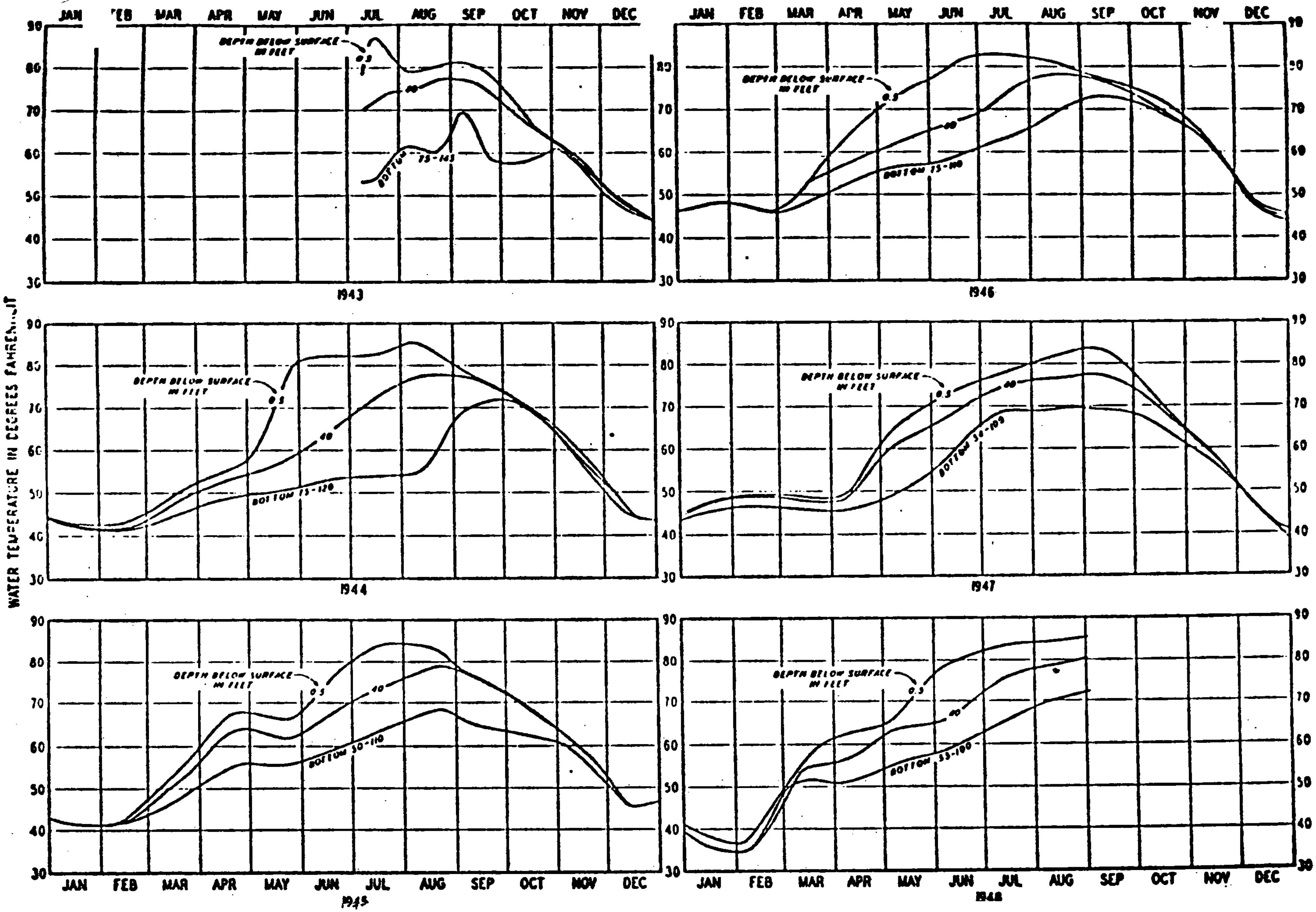

Figure 6.0-3 WATER TEMPERATURE -- DOUGLAS LAKE AT DOUGLAS DAM, TENNESSEE MILE 32.3

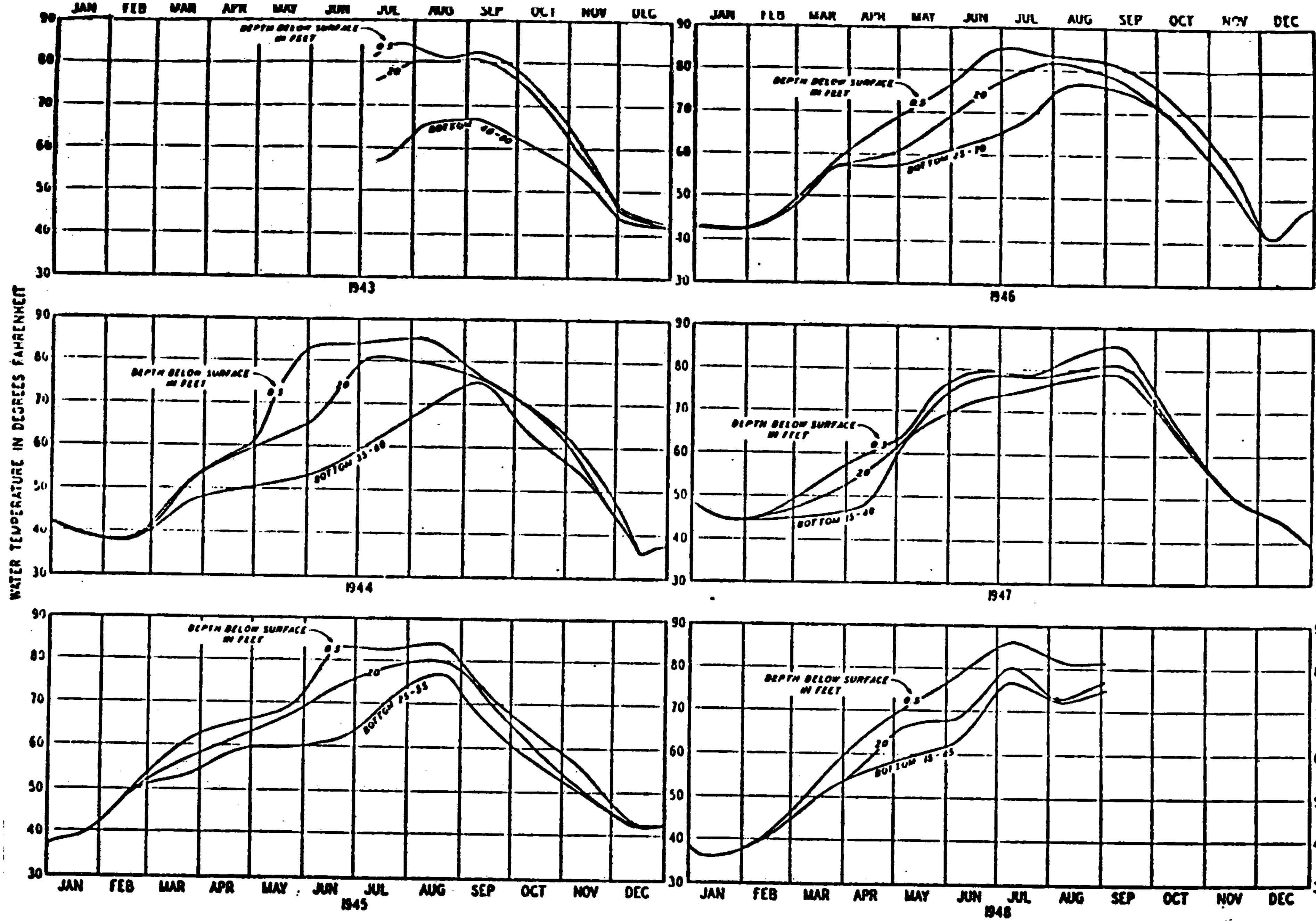

Figure 6.0-4 WATER TEMPERATURE -- DOUGLAS LAKE AT SWANN BRIDGE, TENNESSEE, HWYS. 70 AND 25W, MILE 54.4

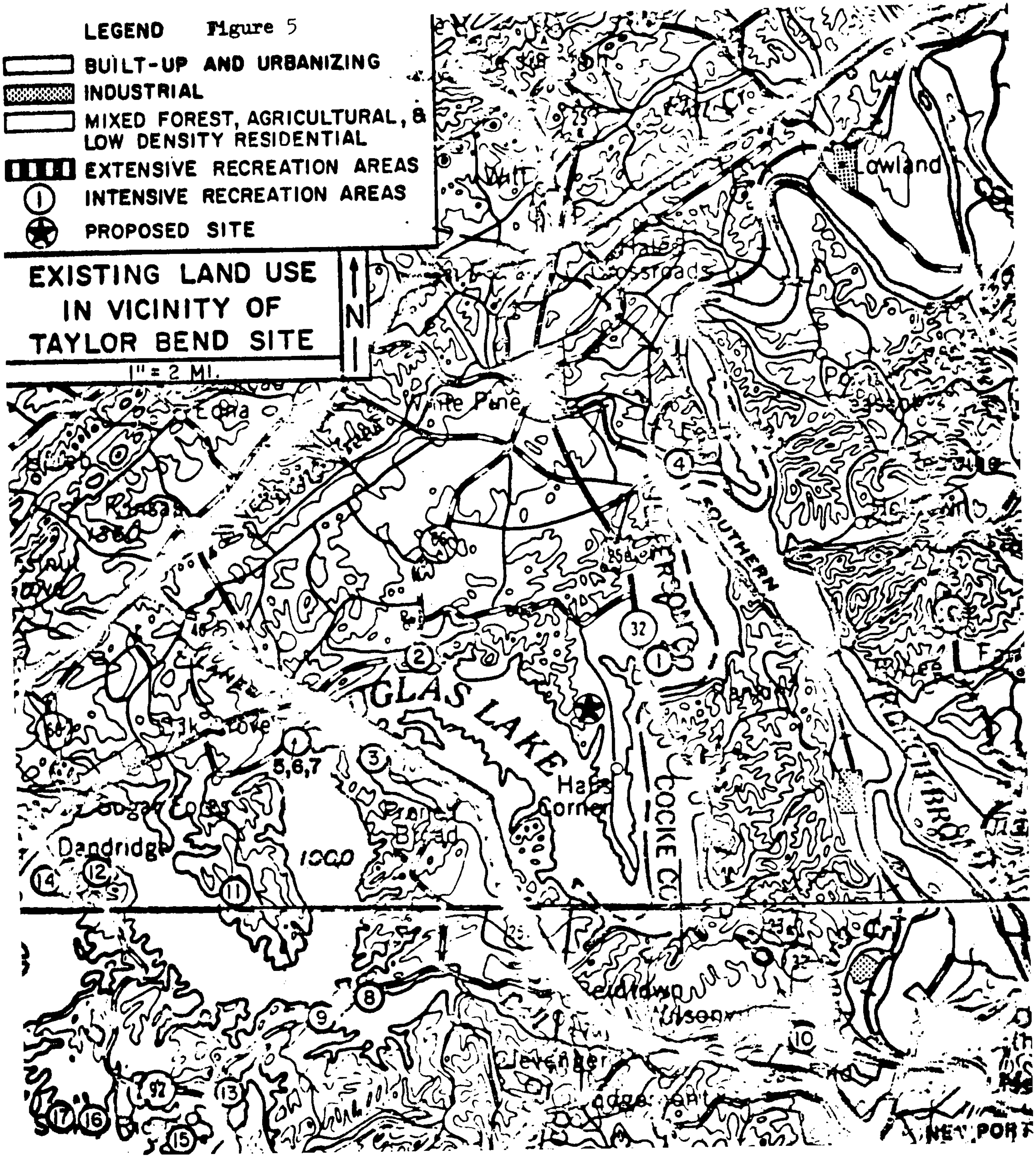

Figure 6.0-5 EXISTING LAND USE IN VICINITY OF TAYLOR BEND SITE

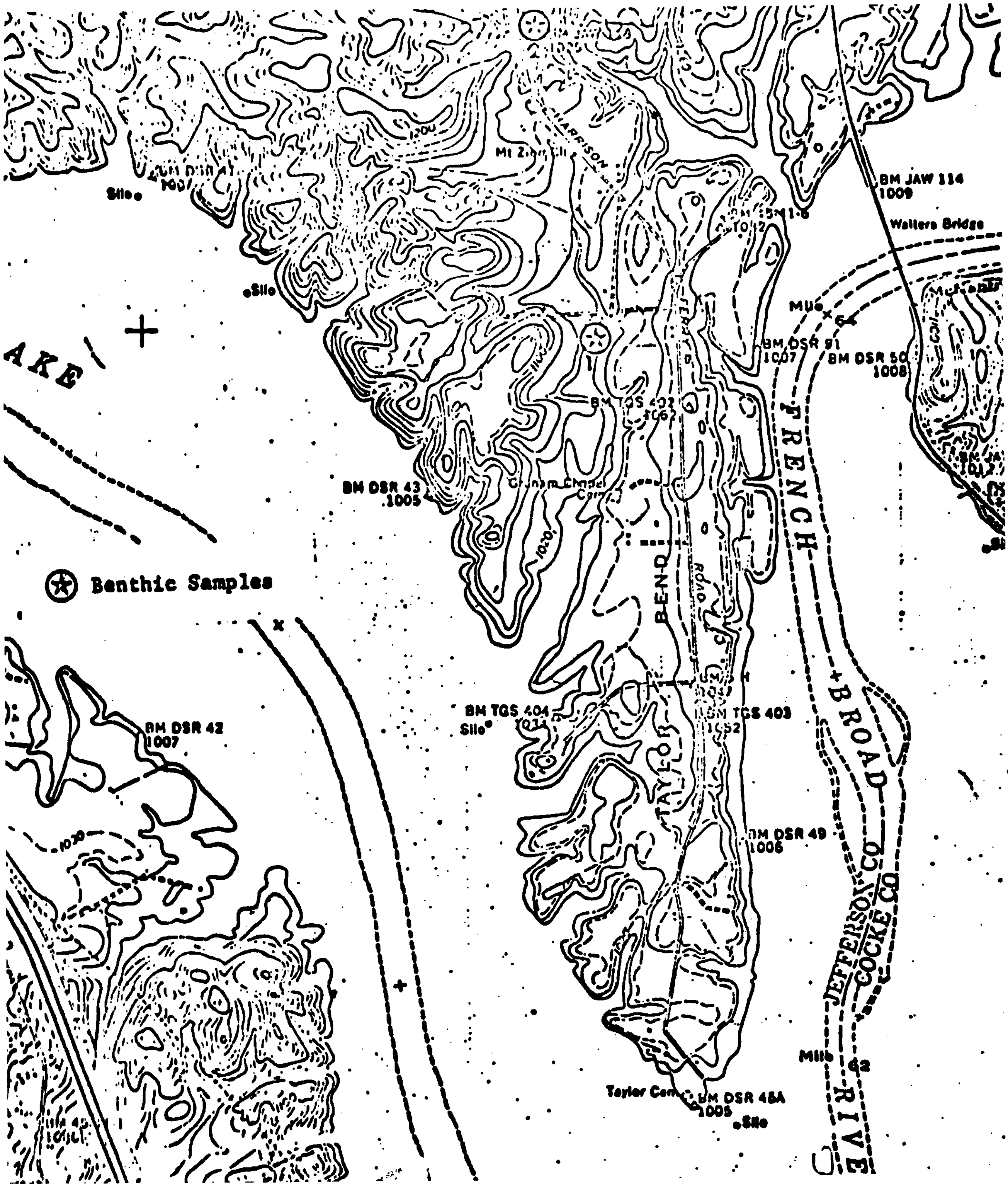

Figure 6.0-6 TAYLOR BEND -- SITE OF PROPOSED POWER PLANT

APPENDIX I TO SECTION 6.0

OF

APPENDIX A

ARCHAEOLOGICAL SURVEY REPORT

TAYLOR BEND

ARCHAEOLOGICAL SURVEY OF THE TAYLOR BEND STEAM PLANT SITE ON DOUGLAS LAKE NEAR WHITE PINE, JEFFERSON COUNTY, TENNESSEE

Dr. Major C. R. McCollough
Research Assistant Professor
Department of Anthropology
The University of Tennessee

Conducted for the Tennessee Valley Authority
in Accordance with Contract TV-36493A

February 15, 1973

ABSTRACT

On January 20, 1973, Dr. Major C. R. McCollough and two trained field assistants, Mr. Lloyd N. Chapman and Mr. Howard Earnest, Jr., conducted a surface survey of the Taylor Bend steam plant site for the purpose of locating and evaluating archaeological sites and historic features which would be affected by steam plant construction and operation in this area. No archaeological sites or surface indications, pointing to prehistoric human occupation or utilization of the zone, were found strictly within either the central plant area or the larger exclusion circle. The plant site does, however, lie adjacent to bottom lands ("Dutch Bottoms" and "Indian Walk Shoals", intermittently inundated by the waters of Douglas Lake) which have long but inadequately been known as the loci of numerous rich archaeological sites. The survey was extended to the small section of temporarily-exposed bottom terraces which was considered likely to be affected by plant construction; three Woodland sites and a single surface indication were encountered in this section. Surface collections from the latter sites, described in the following report, are stored in the Department of Anthropology, The University of Tennessee.

The revised central area of the Taylor Bend plant site lies in and on both sides of a small stream which flows southward into the French Broad River (Douglas Lake), just above the point in the stream valley where the normal pool (1000 foot elevation) ceases to flood the stream channel (Figure 1). The central core drilling area is largely wooded with small mixed deciduous-coniferous cover, further marked by small canebrakes in the stream bottom and laurel groves on its flanks. Surrounding terrain within the larger exclusion area consists of high alluvial terraces, the highest terrace being at elevation 1100'AMSL, one hundred fifty feet above the pre-impoundment level of the French Broad River. The generalized soil profile for the entire area of the upland exclusion area comprises:

A-B Horizon	(including plow zone)--thickness 1.5 feet. Gray-brown clayey loam with small terrace gravel derived from C horizon.
C Horizon	--thickness 2.0-3.0 feet. Bright red-brown clayey loam incorporating large quartzite terrace gravel.
Shale Bedrock	At many locations less than 3.0 feet below present surface, and exposed in stream channels, road cuts, and margins of Douglas Lake.

The methodology and terminology employed in the conduct and reporting of the Taylor Bend survey are those which have been described in detail in an earlier and entirely comparable report (McCollough n.d.:1-3). All available surface exposures in the steam plant area were investigated in the course of the survey, and these included:

a. the entire wooded area which is the locus of core drilling, in which a considerable amount of disturbance has been effected by TVA equipment and relatively large exposures of topsoil could be surveyed;

b. plowed fields and those with standing or harvested crops;

c. areas recently opened by the Lakeland residential-recreational development, an 1100-acre project which continuously borders on and intrudes into the exclusion area on West, North and East sides--a complex network of newly-graded roads, a nine-hole golf course under construction on the East side of Harrison Ferry Road, and another projected nine-hole course on the West side of the road which may abut the projected central area of the Tennessee Valley Authority construction zone (Figure 1);

d. and the denuded slopes of the lower stream valley, made accessible by the current low level of Douglas Lake, 942'AMSL, which closely approximates the original river level.

Absolutely no evidence of prehistoric occupation was encountered strictly within either the central core-drilling area or the larger exclusion circle by the survey party. The personnel of the Lakeland development reported that they had encountered no such evidence in their recent extensive clearing and grading operations, and resident farmers who were contacted reported no significant sites or stray finds in this upland area. The latter informants referred consistently to sites on the lower, flooded terraces of the river at Taylor Bend which have been known to exist for some time and have been officially, although inadequately, recorded in state survey files (see below). It is this author's opinion that the absence of sites within the exclusion area proper is not only apparent, but real, the whole of the immediate upland zone presenting only undisturbed upper soil horizons and derived terrace gravels, even at the few locations which would seem to have been most favorable for prehistoric occupation.

The only historic feature of consequence which was encountered by the survey party is the Graham Chapel Cemetery (Figure 1)--containing ca. 75 graves, many of them unmarked, which dated interments made between 1800 and 1963.

The broad, lowlying terraces of the French Broad River immediately to the West and South of the plant site, colloquially known as the "Dutch Bottoms" locality, are the loci of many important archaeological sites, none of which has apparently been professionally surveyed, tested, or excavated, either before or after the impoundment of Douglas Lake; these sites have been collected and potted by amateurs on a scale scarcely equalled in any other locality of upper East Tennessee, and their exact locations and contents are largely unknown. The previously-known sites in closest proximity to the steam plant site are shown on Figure 1; site designations are in the Lewis and Kneberg system, and the inexactitude of locations and attributions is due to the fact that most information was supplied by collectors and not further investigated. In essence, the right-bank margin of the French Broad River along the four-mile strip immediately Southwest of the steam plant site has previously been identified as a single mammoth site, 9Je9, with ill-defined subunits. The descriptive entry for the site in the state survey files maintained at the McClung Muesum (University of Tennessee n.d.) reveals little more than that a wide range of Woodland and post-Woodland occupations are represented somewhere on the "site":

> Village sites and small occupation areas extending continuously along bank for several miles. Characterized by many pits containing fire-cracked rocks. Pottery: Watts Bar Fabric Marked and Cord Marked, Deptford Check Stamped, Mossy Oak Simple Stamped, Cherokee types from lower end of site (from earlier site survey). Surface collection of Reeves includes Watts Bar Fabric Marked and Long Branch Fabric Marked. Burial excavated by Reeves seems to be flexed Woodland burial. Camp Creek projectile point in possible association.

A "substructure" (presumably Mississippian) mound (site 17Je9) and a stray find of a raptorial bird pendant were reported in the downstream end of the large site (Figure 1), and an apparently distinct concentration of material has been marked, but not otherwise identified, at the mouth of the small stream which drains southward from the steam plant site.

Large and likewise ill-defined sites have also been reported for the left bank directly opposite Site 9Je9.

The January, 1973 steam plant survey was extended southwestward along the stream valley which drains the proposed construction zone, to its confluence with the French Broad River, on the assumption that extensions of construction, plant connections with the lake, watershed alterations, etc. would most likely follow this path. Indications of significant prehistoric occupation were found on the stream valley slopes and terraces, immediately outside the plant exclusion area on terrain denuded and silted-over by high water of Douglas Lake, in the form of one minor surface indication and three sharply-delimited sites which are probably attributable to the Woodland period. This rapid survey was facilitated by a low water level in Douglas Lake (942'AMSL on January 20, 1973, closely approximating the original river level in this vicinity) which presented broad expanses of denuded bottom land. From the heights above Dutch Bottoms, distinct prehistoric sites could easily be discerned by visual inspection, marked by dense concentrations of fire-cracked stone and differentially dark soil coloration. It should be noted that at low water, our knowledge of the specific locations, sizes, and configurations of the component sites in the rich 9Je9 locality could be greatly advanced by the simple means of aerial reconnaissance survey.

Among the specific prehistoric occupation sites to be described below as "discovered" by the 1973 survey party, sites 40JE26 and 40JE27 may have been included in the almost-worthless 9Je9 designation, although they are situated on slightly higher terrace locations than are indicated for 9Je9 in the survey records; in contrast, site 40JE25 and Surface Indication 1, situated on even higher terraces, are unlikely to have been collected or significantly disturbed in the past. All of the sites have been intermittently inundated and to varying degrees, destroyed, by Douglas Lake. If the stream valley and adjacent bottom land Southwest of the plant area are affected by plant construction or use, rich archaeological data remaining in the Douglas Lake pool, including those described below, are certain to be totally destroyed; provisions should be made in that case to test and salvage sites detailed in this report which would be affected, and in fact to test all low terrace loci on a proposed right-of-way because the concentration of archaeological sites is so dense and silting may obscure some of the major sites. If connections with the river are envisioned, they would better be made to the East of the plant construction zone (mile 63.7 area on Douglas Lake) where there are no low level terraces, due to river cutting into the shale bluff.

Surface Indication 1

36°01'50"N.Lat., 83°16'26"W.Long., elevation 980'AMSL

This prehistoric locus is situated high on the steep western slope of the stream valley, just south of the plant exclusion circle within the area denuded and regularly flooded by Douglas Lake, but less than seventy-five feet from the lake's high water line (Figure 1). Here a small amount of material (N=5) was found in a 50' x 50' area of the denuded slope:

Projectile points/knives	
Side nothced serrated (cf. Palmer)	-1
Scrapers	
Hollow side (spokeshave)	-1
Bifaces	
Crude leaf-shaped, vein quartz	-1
Flakes	
Unretouched	-1
Cores	
Block	-1

An Archaic, possibly Early Archaic, attribution is advanced for this surface indication, and it is suspected that the material could have been washed to its present position on the slope from an undisturbed deposit at a slightly higher elevation, although no other exposed point of derivation could be found at the time of the survey. Testing at this locus, if required, would consist of small test pits at the present location of the material and at two points directly upslope, near the high water line and on the edge of the 1000' terrace.

<u>Site 40JE25</u>

<u>36°01'45"N.Lat., 83°16'36"W.Long., elevation 970'AMSL</u>

This site is situated on the leading edge of a small high terrace bench formed by downcutting of the small stream through the main river terraces; the location is 1600 feet East of the right bank of the French Broad River and 400 feet North of the small stream channel (Figure 1). It moreover lay in close proximity to two modern features which were relocated or destroyed when Douglas Lake was impounded--Moore Cemetery, situated 200 feet to the North, and an unimproved road leading from Halls Corner to Nina, which passed within ca. 75 feet of the site to the West. The site is now manifest as a dense concentration of fire-cracked quartzite cobbles and artifacts in a narrow band encircling the riverward edge of the bench point, and from present surface indications and dimensions of the site appear to be 50'(NE-SW) x 100'(NW-SE). The site area has been denuded by lake waters, but the effects of silting are minor compared with those on the lower terraces. Nevertheless, the site is probably larger than the estimate would indicate, extending northeastward onto the level area of the small bench; silting and redistribution of archaeological materials could have skewed the original surface configuration of the site. A small but highly varied surface collection indicates that this was a small, well-delineated base camp on which a wide range of activities were carried out in Middle/Late Woodland times (N=47):

Projectile points/knives	
Small straight base lanceolate	-1
Fragments: segment	-1
Scrapers	
End	-1
Side	-1
Perforators	
Fragments: segment	-2
Flakes	
Misc. retouched	-4
Unretouched	-17
Cores	
Amorphous: Quartz	-1
Flint	-3
Nutstones	
Fragmentary, quartzite	-1
Ceramics, aboriginal	
Grit-tempered cordmarked	-3
Grit-tempered residual	-1
Limestone-tempered plain	-1
Limestone-grit-tempered net impressed	-1
Limestone-grit-tempered cordmarked	-4
Limestone-grit-tempered plain	-2
Limestone-grit-tempered residual	-2
Ceramics, historic	
Blue feather-edge ware (ca. 1820-1840)	-1

As stated above, site 40JE25 is likely to have been disturbed little, if at all, in recent times, in contrast to the large-scale collecting and potting which have been reported for the lower areas in Dutch Bottoms. The site should be given high priority for testing, should further disturbance be envisioned to result from plant construction and use, and the reasons are several. The site location is unusually high and optimally situated for use of both river and tributary stream resource areas, as well as lowland and highland resources; multi-activity status is demonstrated for the compact occupation (perhaps a single house site), on which, ideally, evidence of all such activities could be easily recovered by archaeological means; the site is intact relative to many others in the locality and probably comprises undisturbed midden deposits, but has been destroyed and veiled to an undetermined extent by Douglas Lake, verifiable only be testing; professional testing and/or excavation would furnish essentially unique data concerning Middle/Late Woodland occupations in the area; and one artifact in the surface collection. The extent of damage to the site due to fluctuations in lake level, potting, etc. could be determined only by testing, but is assumed to have been heavy in this case. A short-term testing program is recommended for site 40JE26 should plant construction threaten further damage.

Site 40JE27

36°01'34"N.Lat., 83°16'42"W.Long., elevation 950'AMSL

This site lies adjacent to 40JE26 on the first low floodplain terrace above the right bank of the French Broad River, in an entirely analogous position but on the South side of the stream cut; it lies 1000 feet Southeast of 40JE26, 900 feet East of the river bank, and 400 feet South of the stream channel (Figure 1). As in the case of site 40JE26, the occupied area (50' x 150', long axis N-S) can be recognized from a distance as an oval of dark soil littered with fire-cracked stone, in a surrounding context of featureless silt. On site 40JE27, the concentration of artifacts and rock is greatest in a narrow band on the riverward edge of the terrace lobe; this feature, which may be compared with that observed on site 40JE25, is attributed to the combined effects of stream and lake waters in a fluctuating lacustrine environment and probably does not reflect the original distribution of material on the site. Materials recovered from 40JE27 (N=11) comprise:

Scrapers	
End	-1
Side	-1
Bifaces	
Thick fragmentary	-1
Thin fragmentary	-1

Flakes	
Unretouched	-2
Cores	
Crude subconical	-1
Amorphous	-1
Slate	
Fragment, retouch one edge	-1
Fired clay	
Chunk w/unidentified impressions	-1

No definite cultural attribution can be made on the basis of the small surface sample exposed at the time of survey, but site 40JE27 is tentatively identified as a base camp occupied during the Woodland period; the presence of a rich midden deposit is suspected, and the extent to which its archaeological value has been destroyed by inundation could be determined only by testing.

An attempt was made to survey a presumably significant site which was plotted on old state survey maps (no other data available), lying between sites 40JE26 and 40JE27 on the same low terrace but only 200 feet from the right bank of the river (Figure 1). It was impossible to reach this location on foot, but its surface characteristics could be observed to be identical to those of 40JE26 and 40JE27 (oval area of dark soil discoloration and heavy concentration of fire-cracked stone).

REFERENCES CITED

MCCOLLOUGH, MAJOR C. R.
n.d. Archaeological surveys of the Antioch and Johntown steam plant sites on Old Hickory Reservoir near Gallatin, Tennessee. Conducted for the Tennessee Valley Authority in Accordance with Contract TV-36493A. Submission date September 15, 1972. 33pp., 2 fig.

UNIVERSITY OF TENNESSEE
n.d. State of Tennessee site survey records. On file, McClung Museum, University of Tennessee, Knoxville.

APPENDIX II TO SECTION 6.0

OF

APPENDIX A

FISH SURVEY REPORT

DOUGLAS RESERVOIR

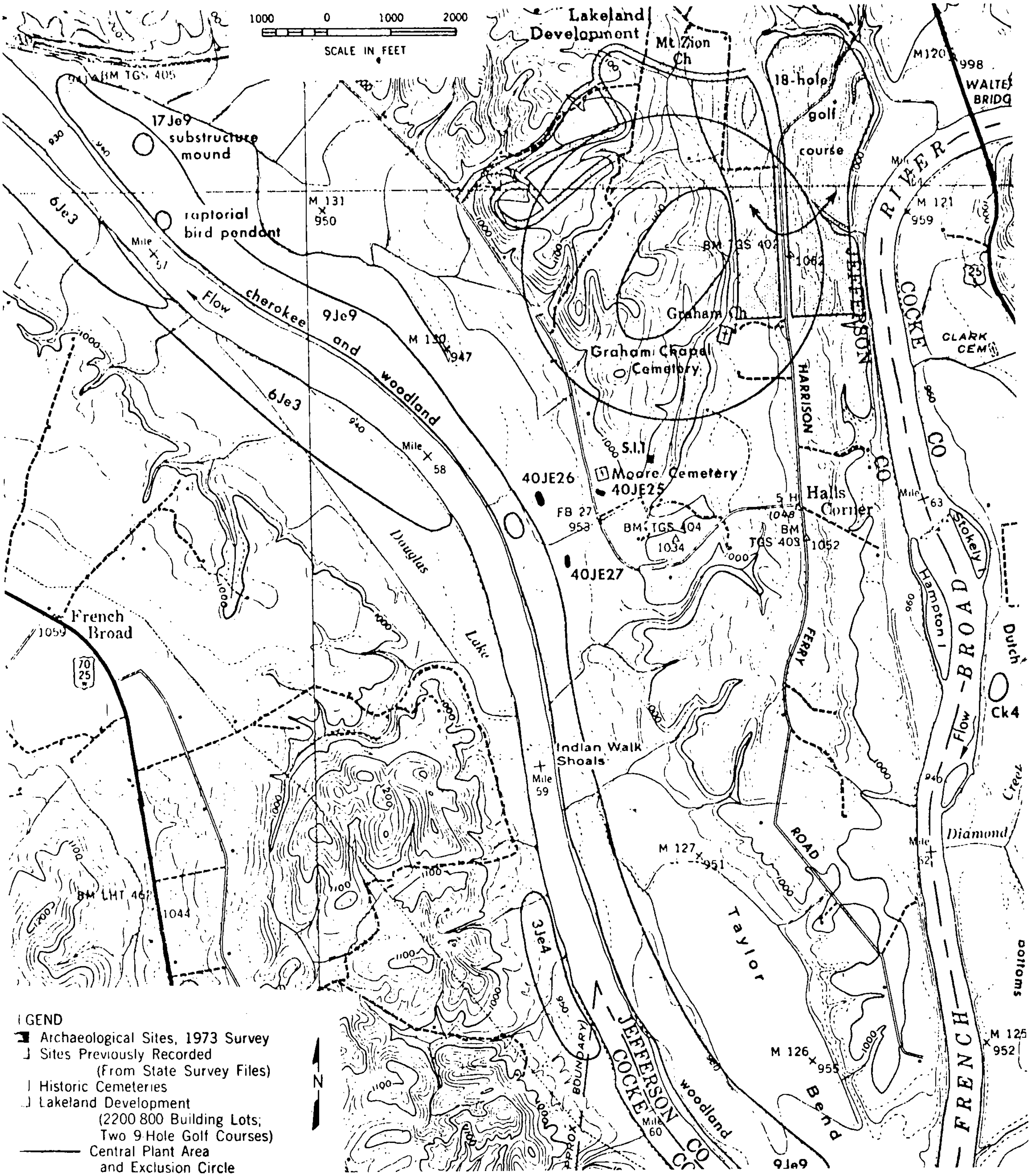

Figure 1 TAYLOR BEND SITE -- KNOWN ARCHAEOLOGICAL RESOURCES, 1973

FISH INVENTORY DATA, DOUGLAS RESERVOIR, 1973

Introduction

This report contains recently gathered information on fishes living along the shoreline and in the coves of Douglas Reservoir. It gives the result of sampling studies done during June 1973 by the Tenneseee Valley Authority.

Technical data presented will be used by various agencies involved with fish management and fishery resource development. They should be helpful to biologists called on to investigate fish kills or other effects of changes in water quality, to evaluate the introduction of exotic fish into the reservoir, and to assess the impact of any future changes in this lake or on its watershed.

Specific data reported here reflect the number, size, mass, and variety of species found and indicate reproductive success of the various fishes which inhabited the cove and shoreline areas of Douglas Reservoir in 1973. This littoral zone is the most productive; it is where most fish and fishing activity occurs, and where the most representative fish population samples can be taken in a large lake.

This report was prepared by TVA biologist Tommy L. Sheddan.

FISH INVENTORY DATA DOUGLAS RESERVOIR

Sample Areas and Procedures

Douglas Reservoir is in Sevier, Hamblen, Jefferson, and Cocke Counties, Tennessee. The dam, at French Broad River kilometer 51.9, was completed in 1943. At full pool (elevation 1000 MSL) Douglas Reservoir has a total surface area of 12,302 hectares. During the sample period, June 4 and June 29, lake elevation fluctuated between 995.9 and 998.3 MSL; reservoir area varied between 11,622 and 12,020 surface hectares; and surface temperatures varied between 24°C and 31°C.

No coves adequate for sampling were found above river kilometer 96.6. The remainder of the reservoir was divided into four major areas (see map) and three coves sampled in each area (Table 1). Cove size ranged from .27 to .82 surface hectares, average depth from 1.8 to 3.7 meters. Surface to bottom water quality in the coves ranged as follows: dissolved oxygen 13.5 to 2.4 mg/l; temperature 30.2°C to 19.8°C. Similar data were found in the river channel.

Field procedures for treatment of each cove and collection of data followed methods accepted for cove rotenone sampling throughout the Southeast. Coves were blocked with nets and treated at the rate of 1 mg/l with 5% emulsifiable rotenone; fish were picked up for two days. A complete list of the fishes found in this inventory is given in Table 2; size classes and subsamples used in data analyses are shown in Table 3.

Summary of Findings

Average cove population--40,006 fish and 285.5 kilograms per hectare (Table 4).

Major fish classes by number--game 91 percent, rough 1 percent, forage 8 percent (Tables 5 and 8).

Major fish classes by weight--game 30 percent, rough 62 percent, forage 8 percent (Tables 5 and 8).

Dominant species by number--larval crappie 53 percent, largemouth bass 36 percent, gizzard shad 7 percent, and bluegill 1 percent (Table 6).

Dominant species by weight--smallmouth buffalo 27 percent, carp 21 percent, white crappie 12 percent, and channel catfish 8 percent (Table 6).

Size distribution of game fish by number--young-of-year 98 percent, intermediates 1 percent, harvestable (adults) 1 percent (Tables 7 and 8).

Size distribution of all fish by number--young-of-year 96.6 percent, intermediate 1.6 percent, harvestable (adults) 1.8 percent (Table 8).

Spawning success--good survival of young-of-year crappie, largemouth bass, and gizzard shad; young-of-year numbers of other species were low.

Growth of fish--growth of largemouth bass and black and white crappie was better in 1961 than in 1973. Sauger and channel catfish growth remained about the same.

General Conclusions

The last fish population inventory on Douglas Lake was done in August 1961, although for a special study a 46.5 hectare arm and several subcoves were rotenoned in September 1965 (Hayne, Hall and Nichols).

In 1961 there were 5,525 fish and 85 kilograms per hectare compared to 40,006 fish and 286 kilograms per hectare in 1973. Because the 1973 sample was done two months earlier, many more larval fish were collected, and a comparison of total numbers of young fish is not valid. However, there was a significant increase in numbers and weights of intermediate and harvestable fish in 1973. Keeper size sport fish increased from 235 fish and 15 kilograms per hectare in 1961 to 1,156 fish and 98 kilograms per hectare in 1973. Individual sport species that showed significant increases in intermediate and harvestable sizes included crappie*, largemouth bass, channel catfish, bluegill, and sauger. Rough fish increased

*Combined black and white crappie. White make up about 95% of the intermediate and harvestable crappie population.

from 217 fish and 36 kilograms per hectare in 1961 to 494 fish and 177 kilograms per hectare in 1973. Forage fish numbers and weights were similar in both years.

Threadfin shad numbers were low. This may be due to the early sample date, possibly before major shad spawn occurred. Low numbers of threadfin shad may account for the slower growth rates of black and white crappie and largemouth bass in 1973 over 1961.

Douglas Reservoir's standing fish crop of 286 kilograms of fish per hectare in 1973 is much above the 13-year average of 181 kilograms per hectare for Tennessee Valley tributary reservoirs. Douglas Lake now has the largest standing crop of game fish, especially crappie and bass, of any tributary reservoir in the Tennessee Valley.

Samples in Area IV in the upper end of the lake had the highest average standing crop of fish. This area contains a site for a possible new TVA steam plant.

Literature Cited

Inventory of Fish Populations, Douglas Reservoir, 1961. TVA. Fish and Wildlife Branch. 9pp.

Standing Crop and Sport and Commercial Catch Data for TVA Reservoirs, February 1973. TVA. Fisheries and Waterfowl Resources Branch.

An Evaluation of Cove Sampling of Fish Populations in Douglas Reservoir, Tennessee. November 1968. Hayne, Hall and Nichols.

Table 1. SAMPLE AREA LOCATIONS, DOUGLAS RESERVOIR, 1973

Data from U.S. Geological Survey Topographic Maps, 7.5 minute series, 1961

Douglas Dam Quadrangle (Topographic) 156 NE

AREA I

Cove 1 Flat Creek Arm near Saddle Dam #6. 120°SE of BM DSR 68,1009

Shady Grove Quadrangle (Topographic) 164 NW

Cove 2 French Broad River kilometer 55.5 on the islands. 103° SE of BM DSR 96,1008

Cove 3 F.B.R. kilometer 59.1 McCracken Branch NE (left hand) prong.

AREA II

Cove 1 F.B.R. kilometer 62.8, right bank* 230° SW of BM 45-17-12, 1045.

Cove 2 F.B.R. kilometer 65.9 Muddy Creek Arm, on an island. 300° NW of BM DSR 76, 1013

Cove 3 F.B.R. kilometer 68.1, left bank 110° SE of BM DSR 10,1010. Back and of long cove.

Chestnut Hill Quadrangle 164 NE

AREA III

Cove 1 F.B.R. kilometer 80.5, Indian Creek Arm 340 NNE of BM 45-36-3, 1079.

Cove 2 F.B.R. kilometer 81.3, left bank 275° W of BM 45-37-8, 1003

White Pine Quadrangle 163 SE

Cove 3 F.B.R. kilometer 85.8, right bank 298° NW of BM DSR 33,1012

AREA IV

Cove 1 F.B.R. kilometer 90.6, right bank 210° (and .6 mile) from BM JAW 110,1013

Cove 2 F.B.R. kilometer 91.7, left bank 270° W of BM DSR 40,1008

Cove 3 F.B.R. kilometer 96.6, left bank

*Left and right banks are indicated when facing downstream.

Table 2. COMMON AND SCIENTIFIC NAMES* OF FISHES IN ROTENONE SAMPLES - DOUGLAS RESERVOIR, 1973

Game

Rainbow trout (Salmo gairdneri)
White bass (Morone chrysops)
Redbreast sunfish (Lepomis auritus)
Warmouth (Lepomis gulosus)
Bluegill (Lepomis macrochirus)
Largemouth bass (Micropterus salmoides)
White crappie (Pomoxis annularis)
Black crappie (Pomoxis nigromaculatus)
Sauger (Stizostedion canadense)

Rough

Spotted gar (Lepisosteus oculatus)
Shortnose gar (Lepisosteus platostomus)
Mooneye (Hiodon tergisus)
Carp (Cyprinus carpio)
River carpsucker (Carpiodes carpio)
Quillback (Carpiodes cyprinus)
Smallmouth buffalo (Ictiobus bubalus)
Golden redhorse (Moxostoma erythrurum)
Shorthead redhorse (Moxostoma macrolepidotum)
Blue catfish (Ictaluris furcatus)
Channel catfish (Ictalurus punctatus)
Flathead catfish (Pylodictis olivaris)
Drum (Aplodinotus grunniens)

Forage

Gizzard shad (Dorosoma cepedianum)
Threadin shad (Dorosoma petenense)
Stoneroller (Campostoma anomalum)
Goldfish (Carassius auratus)
Spotfin shiner (Notropis spilopterus)
Golden shiner (Notemigonus crysoleucas)
Emerald shiner (Notropis atherinoides)
Steelcolor shiner (Notropis whipplei)
Bluntnose minnow (Pimephales notatus)
Logperch (Percina caprodes)

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*From American Fisheries Society Publication Number 6, third edition, 1970

Table 3. SIZE CLASSES* AND SUBSAMPLES USED IN 1973 FISH INVENTORIES

Species	Young-of-year	Intermediate	Harvestable
	------------Length in Millimeters------------		
Game			
White bass	1-150	151-200	201 and over
Yellow bass	1-150	151-200	201 "
Rock bass	1-75	76-125	126 "
Bluegill	1-50	51-125	126 "
Other sunfishes	1-50	51-125	126 "
Smallmouth bass	1-100	101-200	201 "
Spotted bass	1-100	101-200	201 "
Largemouth bass	1-100	101-225	226 "
Crappie	1-75	76-175	176 "
Sauger	1-200	201-275	276 "
Walleye	1-200	201-275	276 "
Rainbow trout	1-150	-	151 "
Rough			
Gar	1-300	301-475	476 "
Skipjack herring	1-150	151-275	276 "
Mooneye	1-150	151-275	276 "
Carp	1-200	201-300	301 "
Carpsuckers	1-200	201	226 "
Buffalo	1-200	201-300	301 "
Redhorses	1-175	176-250	251 "
Bullhead	1-100	101-175	176 "
Blue catfish	1-125	126-225	226 "
Channel catfish	1-125	126-225	226 "
Flathead catfish	1-125	126-275	276 "
Drum	1-125	126-200	201 "
Forage**			
Threadfin shad	1-125	-	126 "
Gizzard shad	1-125	-	126 "
Miscellaneous forage fishes	-	-	

Subsamples: Mixed threadfin and gizzard shad (125 mm and less) - 3 kg
Mixed species other than shad (75 mm and less) - 1.5 kg
Sorted individual species (75 mm and less) - 1.5 kg

*The size class divisions for each species are arbitrary, but based on knowledge of growth rates and information from creel census and commercial harvest records.

**Shad were recorded either as young-of-year or adult; sizes of other forage fish were not differentiated.

Table 4. STANDING CROP OF FISH BY SAMPLE AREA, DOUGLAS RESERVOIR, 1973

Sample Area	Size		Mean Depth		No. of fish		Weight by fish	
	Acres	Hectares	Feet	Meters	Acre	Hectare	Pounds/ Acre	Kilograms/ Hectare
Area I								
Cove 1	1.06	0.43	10.9	3.22	2,871	7,094	312.2	350.2
Cove 2	1.39	.56	9.8	2.38	16,578	40,966	111.6	125.2
Cove 3	1.69	.68	10.0	3.05	33,188	82,010	112.9	126.6
Area II								
Cove 1	2.03	.82	12.1	3.69	11,748	29,029	169.2	189.7
Cove 2	0.87	.35	10.2	3.11	11,097	27,420	217.7	244.1
Cove 3	1.08	.44	6.2	1.89	48,794	120,571	407.6	257.1
Area III								
Cove 1	0.93	.38	8.3	2.53	20,080	49,620	196.0	219.8
Cove 2	1.45	.59	9.5	2.90	18,436	45,556	423.5	474.9
Cove 3	1.17	.47	8.6	2.62	11,419	28,216	191.8	215.1
Area IV								
Cove 1	0.66	.27	9.7	2.96	12,692	31,364	866.9	972.2
Cove 2	1.65	.67	9.0	2.74	3,067	7,578	206.8	231.9
Cove 3	1.49	.60	12.3	3.75	6,653	16,442	237.9	266.8
All areas	15.47	6.26	9.55	2.91	16,190	40,006	254.6	285.5

Table 5. AREA POPULATIONS FOR MAJOR FISH GROUPS, DOUGLAS RESERVOIR, 1973

Sampling Area Description	Fish Group	Number of Species	No. of Fish Acre	No. of Fish Hectare	Weight of fish Pounds/ Acre	Weight of fish Kilograms/ Hectare
Area I						
3 samples	Game	7	19,646	48,546	48.4	54.3
4.14 acres (1.68 ha)	Rough	10	99	245	108.8	122.0
June 5-12, 1973	Forage	9	96	237	6.3	7.0
		26	19,841	49,028	163.5	183.3
Area II						
3 samples	Game	6	21,078	52,085	93.7	105.1
3.98 acres (1.61 ha)	Rough	9	187	462	132.4	148.5
June 12-14, 1973	Forage	6	393	971	18.4	20.6
		21	21,658	53,518	244.5	274.2
Area III						
3 samples	Game	7	12,933	31,958	92.7	104.0
3.55 acres (1.44 ha)	Rough	9	272	672	174.2	195.3
June 19-21, 1973	Forage	8	3,349	8,276	20.7	23.2
		24	16,554	40,906	287.6	322.5
Area IV						
3 samples	Game	7	4,286	10,591	72.5	81.3
3.80 acres (1.54 ha)	Rough	12	256	633	225.0	252.3
June 21-28, 1973	Forage	8	1,603	3,961	36.2	40.6
		27	6,145	15,185	333.7	374.2
All areas						
12 samples	Game	9	14,701	36,327	76.2	85.5
15.47 acres (6.26 ha)	Rough	13	200	494	158.4	177.6
June 5-28, 1973	Forage	10	1,289	3,185	20.0	22.4
		32	16,190	40,006	254.6	285.5

Table 6. SPECIES COMPOSITION OF COVE POPULATIONS, DOUGLAS RESERVOIR, 1973

Species	Percent of total number	Percent of total weight
Crappie*	53.0	2.9
Largemouth bass	35.6	5.9
Gizzard shad	6.8	6.7
Bluegill	1.3	5.4
White crappie	.8	11.8
Bluntnose minnow	.5	.1
Smallmouth buffalo	.5	26.7
Threadfin shad	.3	.1
Drum	.3	3.1
Channel catfish	.2	8.3
Logperch	.2	.1
Carp	.2	21.1
Sauger	.2	3.2
Golden shiner	.1	.4
Goldfish	t	.5
Black crappie	t	.6
Mooneye	t	.2
Spotted gar	t	.7
Warmouth	t	.1
Quillback	t	.6
Flathead catfish	t	.8
Spotfin shiner	t	t
Stoneroller	t	t
Redbreast sunfish	t	.1
Golden redhorse	t	.1
River carpsucker	t	.3
Shortnose gar	t	.1
Emerald shiner	t	t
White bass	t	t
Shorthead redhorse	t	t
Steelcolor shiner	t	t
Blue catfish	t	.1
Rainbow trout	t	t

*Larval

t = less than 0.05 percent

Table 7. SIZE DISTRIBUTION PER HECTARE BY SPECIES, DOUGLAS RESERVOIR, 1973

Species	Young-of-year		Intermediate		Harvestable		Total	
	No.	Kg.	No.	Kg.	No.	Kg.	No.	Kg.
Crappie[a]	21,193	8.4	--	--	--	--	21,193	8.4
Largemouth bass	14,138	2.4	27	3.1	34	11.4	14,199	16.9
Gizzard shad	2,622	2.8	*	*	97	16.4	2,719	19.2
Bluegill	142	0.2	209	5.3	149	9.9	500	15.4
White crappie	--	--	132	3.6	204	29.9	336	33.5
Bluntnose minnow[b]	193	0.3	--	--	--	--	193	0.3
Smallmouth buffalo	68	5.6	55	12.5	59	58.1	182	76.2
Threadfin shad	122	0.2	*	*	3	0.1	125	0.3
Drum	1	t	88	4.6	23	4.3	112	8.9
Channel catfish	1	t	27	1.6	59	22.2	87	23.8
Logperch	84	0.4	--	--	--	--	84	0.4
Carp	24	0.1	t	t	57	60.1	81	60.2
Sauger	9	0.3	57	6.1	9	2.7	75	9.1
Golden shiner	23	0.3	--	--	21	0.7	44	1.0
Black crappie	--	--	4	0.2	10	1.4	14	1.6
Goldfish	9	t	--	--	5	1.3	14	1.3
Mooneye	--	--	11	0.7	--	--	11	0.7
Spotted gar	7	0.1	1	0.5	2	1.4	10	2.0
Warmouth	t	t	6	0.1	1	0.2	7	0.3
Quillback carpsucker	2	0.1	--	--	3	1.6	5	1.7
Flathead catfish	t	t	t	t	3	2.3	3	2.3
Spotfin shiner	3	t	--	--	--	--	3	t
Stoneroller	2	t	--	--	--	--	2	t
Redbreast sunfish	--	--	--	--	2	0.2	2	0.2
Golden redhorse	1	t	t	t	1	0.3	2	0.3
River carpsucker	--	--	--	--	1	0.9	1	0.9
Shortnose gar	t	t	t	t	t	0.4	t	0.4
Emerald shiner	1	t	--	--	--	--	1	t
White bass	t	t	--	--	1	0.1	1	0.1
Shorthead redhorse	t	t	--	--	--	--	t	t
Steelcolor shiner	t	t	--	--	--	--	t	t
Blue catfish	--	--	--	--	t	0.1	t	0.1
Rainbow trout	--	--	--	--	t	t	t	t
All fish	38,645	21.2	617	38.3	744	226.0	40,006	285.5

a = larval fish

b = minnows considered only as young-of-year

* = shad considered either as young-of-year or adult

t = less than 0.5 percent

Table 8. SIZE DISTRIBUTION OF MAJOR FISH GROUPS, DOUGLAS RESERVOIR, 1973

Fish Groups	Percent by Number				Percent by Weight			
	Young-of-year	Inter-mediate	Harvest-able	Total	Young-of-year	Inter-mediate	Harvest-able	Total
Game	88.7	1.1	1.0	90.8	3.9	6.5	19.5	29.9
Rough	0.2	0.5	0.5	1.2	2.0	7.0	53.2	62.2
Forage	7.7	*	0.3	8.0	1.4	*	6.5	7.9
All Fish	96.6	1.6	1.8	100.0	7.3	13.5	79.2	100.0

*Shad considered either as young-of-year or adult.

Table 9. AVERAGE GROWTH RATES FOR SOME DOUGLAS RESERVOIR FISHES IN 1973 and 1961

Species	Year	No.	Calculated average total length in mm's--end of year 1	2	3	4	5	6	7	8
White crappie	1973	82	33	137	208	270				
	1961	60	81	195	269	330				
Black crappie	1973	28	39	158	198					
	1961	37	109	272	284	292				
Largemouth bass	1973	84	139	240	328					
	1961	33	155	294	371	434				
Sauger	1973	38	216	348	410					
	1961	26	193	343	396					
Channel catfish	1973	100	97	193	276	350	381	418	433	455
	1961	16	91	172	251	294	333	388	434	449
Flathead catfish	1973	17	90	199	326	407				
Bluegill	1973	66	34	91	131	160				

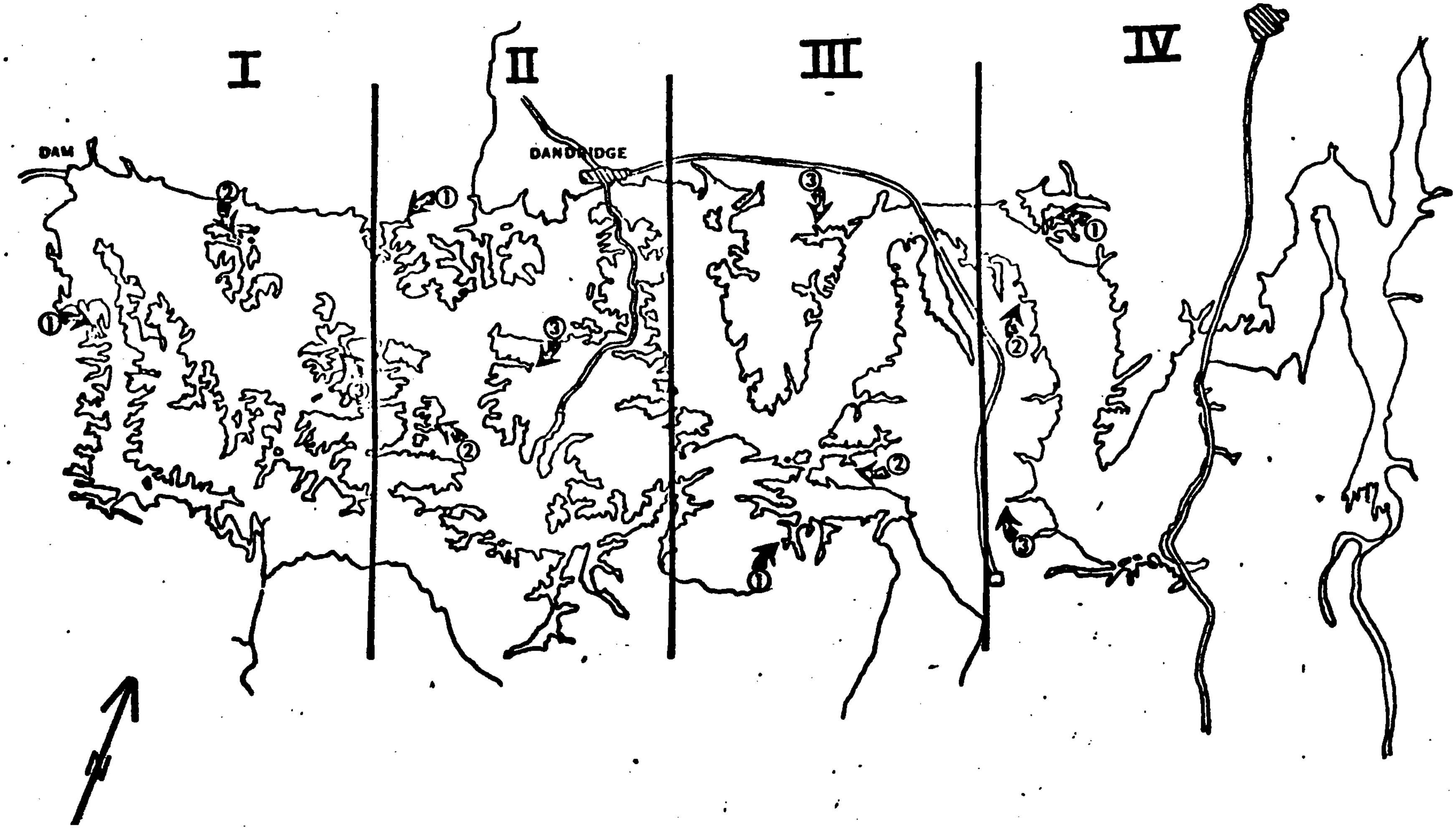

Figure 1 DOUGLAS RESERVOIR -- SAMPLE CAVES, 1973

APPENDIX III TO SECTION 6.0

OF

APPENDIX A

FLORA SURVEY REPORT

TAYLOR BEND

THE FALL FLORA OF TAYLOR BEND,
JEFFERSON COUNTY, TENNESSEE

Allen C. Skorepa[1]

Taylor Bend is a point of land projecting into Douglas Lake about eight miles northwest of Newport in Jefferson County, Tennessee. The area is mostly in private ownerships. About 40 percent of the study area is wooded; the remaining land is composed of pasture, fields and wasteland. Some of it is in cultivation. The forest is situated on steep-sloped hills and is dominated by oak trees. The area is underlain by dolomite, and some outcrops occur. But no interesting plants typical of limestone areas elsewhere in Tennessee were observed.

Observations on the flora were made during October of 1972. Plants in flower or fruit were collected and pressed in the field. They were later identified in the laboratory. Some species were identified in the field and were not collected. Many remnants of the spring and summer flora were found; some could be recognized while others could not be identified due to a lack of flowers. A study of the spring and early flora would reveal a larger number of species. Specimens of most of the species collected in the area have been deposited in the University of Tennessee Herbarium (poor specimens were discarded).

Vegetation of the Major Habitats

Three major habitats are available to plants at Taylor Bend-woodlands, open areas away from the lake, and low, open areas near the lake. A fall flora is typically dominated by sun-loving plants, and, as would be expected, very few plants in flower were found in the woodlands. In the spring, the situation would be reversed. Most herbs of woodlands

1/Department of Botany, University of Tennessee, Knoxville, Tennessee 37916.

mature in April or May before sunlight is excluded by the canopy. Most of the species were found in waste places, fields, and along roads. The largest family in such habitats is Compositae.

Open areas away from the lake are due to disturbance by man, and they form a typical habitat for non-native, as well as native, species. These areas are dominated by herbs such as grasses and composites. The development of trees and shrubs is usually limited to roadsides and fence rows. Some of most conspicuous species are kudzu vine (*Pueraria lobata*), princess-tree (*Paulownia tomentosa*), tree-of-heaven (*Ailanthus altissima*), white mulberry (*Morus alba*), honeysuckle (*Lonicera japonica*), and privet (*Ligustrum sinense*), all of which represent species introduced from Asia. Also common along roads and fences are native species like roses (*Rosa*), blackberries (*Rubus*), elms (*Ulmus*), hackberry (*Celtis occidentalis*), grapes (*Vitis*), Virginia creeper (*Parthenocissus quinquefolia*), persimmon (*Diospyros virginiana*), smooth sumac (*Rhus glabra*), elderberry (*Sambucus canadensis*), sassafras (*Sassafras albidum*), and briers (*Smilax*). Herbaceous plants which are most common along fence rows are milkweeds (*Asclepias*, *Cynanchum*), Indian grass (*Sorghastrum nutans*), purpletop (*Triodia flava*), Canada thistle (*Cirsium arvensis*), ground cherry (*Physalis*), and some nightshades (*Solanum*).

Dipsacus sylvestris (teasel) is an unusual and somewhat rare species that was found once on a roadside bank. This plant reaches a height of seven feet and is covered by spines. The stem is topped by several dry, conical "fruits" which are surrounded by long spines. Teasel is not common in Tennessee but ranges from Missouri to the northeastern states where it is fairly common. Furthermore, it is a native of Europe, which renders its comparative rarity in Tennessee of little significance.

A few ponds in the Taylor Bend area harbor some plants not found in the drier fields. The most typical are sedges (*Cyperus*, *Carex*), rushes (*Juncus*), and cattails (*Typha*).

Most of the species encountered during the course of this study were in fields and pastures. Many of them were introduced from Europe and are considered "weeds." Most of the species belong to the aster family (Compositae--also called Asteraceae) as would be expected in the fall flora of any given area in Tennessee. The most common asters found are ragweed (Ambrosia), aster (Aster pilosus), spanish needles (Bidens), fireweed (Erechtites hieracifolia), fleabane (Erigeron), prickly lettuce (Lactuca scariola), dandelion (Taraxicum officinale), goldenrod (Solidago petiolaris), and frostweed (Verbesina virginica). Other species in Gramineae (grasses), Leguminosae (beans), and Euphorbiaceae (purslanes) combined with Compositae dominate the vegetation of fields at Taylor Bend. These are foxtail (Setaria), clover (Lespedeza, Trifolium, Melilotus) panic grass (Panicum), purslanes (Euphorbia, Croton), crabgrass (Digitaria sanguinalis), goosegrass (Eleusine indica), and broomsedge (Andropogon virginicus).

Certain areas along the lake are regularly inundated, but the water level drops in the late summer and fall, and a terrestrial habitat becomes available for plants. The mud flats exposed by the receding shore line are inhabited by plants that require very wet situations or that typically grow in areas that are only periodically inundated. The most conspicuous plant in the mud flats is cocklebur (Xanthium strumarium). Xanthium is about one foot high, and the plants often form a regular cover over areas of several hundred square feet. Dodder (Cuscuta campestris) is an unusual, non-green, filamentous vine that covers some patches of Xanthium like a spider web. In slightly drier areas further up the shore, the bindweed vine (Convolvulus arvensis) grows vigorously over rocks and other plants. A beautiful Hibiscus bush with large, yellow flowers also grows in wet areas near the lake, it is not too common in Tennessee. Some other plants most typical of lakeside habitats are buttonbush (Cephalanthus occidentalis), sedges (Cyperus, Carex), rushes (Juncus), bachelor's button (Centauria cyanus), buttonweed (Diodia virginiana), lovegrass (Eragrostis poaeoides), moneywort (Lysimachia nummularia), and willow (Salix).

On certain dry slopes the scrub pine (Pinus virginiana) is common, but most of the forested areas are dominated by oaks (Quercus) and hickories (Carya). Willow oak (Quercus phellos) and pin oak (Quercus palustris) are the most important trees in low woods. A few herbs were found only in the low woods in association with willow oaks. They are Palmer's amaranth (Amaranthus palmeri), false nettle (Boehmeria cylindrica), eclipta (Eclipta alba), Indian tobacco (Lobelia inflata), and water pimpernel (Samolus parviflorus).

Trees in the upland woods form a mature forest. They are large, and there is little ground cover, but cattle range through much of the forest detracting from its natural beauty. The oaks which dominate this forest form the largest genus of plants found at Taylor Bend. Other common trees and shrubs include hickories, bladdernut (Staphylea trifolia), spicebush (Lindera benzoin), beech (Fagus grandifolia), black walnut (Juglans nigra), strawberry bush (Euonymus americana), and sugar maple (Acer saccharum).

Floristics

The fall flora of Taylor Bend is represented by 168 species in 56 families. Compositae, Leguminosae, Fagaceae, Gramineae, Euphorbiaceae, Rosaceae, and Solanaceae are the largest families. Twenty-eight families are monotypic or are represented by only one species. The families with 3 or more representatives are listed in Table 1.

Rare Species

No endangered species were encountered during the course of this study. A few species which are considered to be not common in Tennessee were found. Dipsacus and Hibiscus have already been mentioned. Hibiscus moscheutos is considered to be "not common" but is also not rare.

Eragrostis poaeoides is known from only a few localities in Tennessee. This grass grows appressed to mud at the margins of receding lakes. This is a habitat that is not often collected which may, in part, account for the apparent rarity of the grass. This species is widespread in the United States, and it is native to Europe, which lessens its importance as a rare species in any state flora.

Melothria pendula is a native vine of low woods in the southeastern states. It is not very common but occurs in scattered localities in Tennessee.

TABLE 1. The families of plants from Taylor Bend with three or more representatives. Numbers indicate the number of species found.

Compositae	24	Convolvulaceae	4
Leguminosae	13	Juglandaceae	4
Fagaceae	10	Polygonaceae	4
Gramineae	9	Anacardiaceae	3
Euphorbiaceae	5	Cruciferae	3
Rosaceae	5	Liliaceae	3
Solanaceae	5	Salicaceae	3
Aceraceae	4		

LIST OF SPECIES FOUND

The Latin names of the species are listed in alphabetical order. Each name is followed by the common name and the family. The numbers given under "habitat" refer to the habitat in which the species is most typically found as follows:

1. roadsides, fence rows, fields, pastures (open areas away from the lake).
2. low open areas near the lake.
3. low woods or wet areas away from the lake.
4. upland woods.

Latin Name	Common Name	Family	Habitat
Acalypha setosa A. Rich.	Copperleaf	Euphorbiaceae	3
Acalypha virginica L.	Three-seeded mercury	Euphorbiaceae	1
Acer negundo L.	Box Elder	Aceraceae	1
Acer rubrum L.	Red Maple	Aceraceae	3
Acer saccharinum L.	Silver Maple	Aceraceae	3
Acer saccharum Marsh.	Sugar Maple	Aceraceae	4
Ailanthus altissima (Mill.) Swingle	Tree-of-Heaven	Simaroubaceae	1
Allium canadense L.	Wild Onion	Liliaceae	1
Amaranthus palmeri S. Wats.	Palmer's Amaranth	Amaranthaceae	3
Amaranthus spinosus L.	Spiny Amaranth	Amaranthaceae	1
Ambrosia artemisiifolia L.	Common Ragweed	Compositae	1
Ambrosia trifida L.	Great Ragweed	Compositae	1
Ampelopsis cordata Michx.	American Ampelopsis	Vitaceae	3
Andropogon virginicus L.	Broomsedge	Gramineae	1
Arctium minus (Hill) Bernh.	Burdock	Compositae	1
Asclepias syriaca L.	Common Milkweed	Asclepiadaceae	1
Asplenium platyneuron (L.) Oaks	Ebony Spleenwort	Polypodiaceae	4
Aster linariifolius L.	Toadflax	Compositae	1
Aster pilosus Willd.	Aster	Compositae	1
Aster prenanthoides Willd.	Aster	Compositae	2
Aster surculosus Michx.	Aster	Compositae	2

Latin Name	Common Name	Family	Habitat
Bidens bipinnata L.	Spanish Needles	Compositae	1
Bidens tripartata L.	Spanish Needles	Compositae	1,2
Bignonia capreolata L.	Cross Vine	Bignoniaceae	1,4
Boehmeria cylindrica (L.) Swartz	False Nettle	Urticaceae	3
Brassica erucastrum L.	Mustard	Cruciferae	1
Brassica juncea (L.) Cosson	Leaf Mustard	Cruciferae	2
Campsis radicans (L.) Seem.	Trumpet Creeper	Bignoniaceae	1
Carex sp.	Sedge	Cyperaceae	2,3
Carya cordiformis (Wang.) K. Koch.	Bitternut Hickory	Juglandaceae	4
Carya glabra (Mill.) Sweet	Pignut Hickory	Juglandaceae	4
Carya ovata (Mill.) K. Koch.	Shagbark Hickory	Juglandaceae	4
Cassia fasciculata Michx.	Partridge Pea	Leguminosae	1
Cassia occidentalis L.	Coffee Senna	Leguminosae	1
Celtis occidentalis L.	Hackberry	Ulmaceae	1,4
Centauria cyanus L.	Bachelor's Button	Compositae	2
Cephalanthus occidentalis L.	Button Bush	Rubiaceae	2
Cercis canadensis L.	Redbud	Leguminosae	4
Chenopodium album L.	Lamb's Quarters	Chenopodiaceae	1
Chrysanthemum leucanthemum	White Daisy	Compositae	
Cichorium intybus L.	Chicory	Compositae	1
Cirsium arvensis (L.) Robs.	Canada Thistle	Compositae	1

Latin Name	Common Name	Family	Habitat
Cocculus carolinus (L.) DC.	Moonseed	Berberidaceae	1
Convolvulus arvensis L.	Bindweed	Convolvulaceae	2
Croton monanthogynus Michx.	Prairie Tea	Euphorbiaceae	1
Cuscuta campestris Yuncker	Dodder	Convolvulaceae	2
Cynanchum laeve (Michx.) Pers.	Trailing Milkweed	Asclepiadaceae	1
Cynodon dactylon (L.) Pers.	Bermuda Grass	Gramineae	1
Cyperus sp.	Sedge	Cyperaceae	2,3
Daucus carota L.	Queen Anne's Lace	Umbelliferae	1
Desmodium laevigatum (Nutt.) DC.	Beggar Tick	Leguminosae	1
Digitaria sanguinalis (L.) Scop.	Crabgrass	Gramineae	1
Diodia virginiana L.	Buttonweed	Rubiaceae	2
Diospyros virginiana L.	Persimmon	Ebenaceae	1
Dipsacus sylvestris Huds.	Teasel	Dipsacaceae	1
Eclipta alba (L.) Hassk.	Eclipta	Compositae	3
Eleusine indica (L.) Gaertn.	Goosegrass	Gramineae	1
Eragrostis poaeoides Beauv.	Love-Grass	Gramineae	2
Erechtites hieracifolia (L.) Raf.	Fireweed	Compositae	1
Erigeron canadensis L.	Canada Fleabane	Compositae	1
Erigeron strigosus Willd.	Daisy Fleabane	Compositae	1
Euonymus americana L.	Strawberry Bush	Celastraceae	3,4

Latin Name	Common Name	Family	Habitat
Euphorbia dentata Michx.	Euphorbia	Euphorbiaceae	1
Euphorbia maculata L.	Eyebane	Euphorbiaceae	1
Euphorbia supina Raf.	Milk Purslane	Euphorbiaceae	1
Fagus grandifolia Ehrh.	Beech Tree	Fagaceae	4
Fraxinus americana L.	White Ash	Oleaceae	4
Galium aparine L.	Bedstraw	Rubiaceae	1
Gleditsia tricanthos L.	Honey Locust	Leguminosae	1,3
Gnaphalium obtusifolium L.	Rabbit Tobacco	Compositae	1
Helenium tenuifolium Nutt.	Bitterweed	Compositae	1
Hibiscus moscheutos L.	Swamp Rose	Malvaceae	2
Hydrangea quercifolia Bartr.	Oak-leaved Hydrangea	Saxifragaceae	4
Hypericum gymnanthum Engelm. & Gray		Hypericaceae	3
Impatiens pallida Nutt.	Touch-Me-Not	Balsaminaceae	1
Ipomoea hederacea (L.) Jacq.	Morning Glory	Convolvulaceae	1
Ipomoea pruinosa (L.) Roth	Morning Glory	Convolvulaceae	1
Juglans nigra L.	Black Walnut	Juglandaceae	4
Juncus effusus L.	Rush	Juncaceae	1,2
Juniperus virginiana L.	Eastern Red Cedar	Cupressaceae	1

Latin Name	Common Name	Family	Habitat
Lactuca scariola L.	Prickle Lettuce	Compositae	1
Lepidium virginicum L.	Peppergrass	Cruciferae	1
Lespedeza cuneata (Dum.) G. Don.	Bush Clover	Leguminosae	1
Lespedeza stipulacea Maxim.	Korean Clover	Leguminosae	1
Ligustrum sinense Lour.	Privet	Oleaceae	1
Lindera benzoin (L.) Blume	Spicebush	Lauraceae	4
Liriodendron tulipifera L.	Tuliptree	Magnoliaceae	4
Lobelia inflata L.	Indian Tobacco	Campanulaceae	3
Lonicera japonica Thunb.	Honeysuckle	Caprifoliaceae	1
Ludwigia alternifolia L.	Seedbox	Onagraceae	3
Ludwigia linearis Walt.	Slender Loosestrife	Onagraceae	2
Lysimachia nummularia L.	Moneywort	Primulaceae	2
Medicago sativa L.	Alfalfa	Leguminosae	1
Melilotus alba Desr.	White Clover	Leguminosae	1
Melothria pendula L.	Creeping Cuccumber	Cucurbitaceae	3
Morus alba L.	White Mulberry	Moraceae	1
Nyssa sylvatica Marsh.	Black Gum	Nyssaceae	3
Ostrya virginiana (Mill.) K. Koch.	Hop Hornbeam	Betulaceae	4
Oxalis repens Thunb.	Woodsorrel	Oxalidaceae	1

Latin Name	Common Name	Family	Habitat
Panicum oligosanthes Schult	Panic Grass	Gramineae	1,3
Parthenocissus quinquefolia (L.) Planch.	Virginia Creeper	Vitaceae	1,4
Passiflora incarnata L.	Passion Flower	Passifloraceae	1
Paulownia tomentosa (Thunb.) Steud.	Princess-Tree	Scrophulariaceae	1
Physalis heterophylla Nees	Ground Cherry	Solanaceae	1
Physalis pruinosa L.	Ground Cherry	Solanaceae	1,3
Phytolacca americana L.	Pokeweed	Phytolaccaceae	1
Pinus virginiana Mill.	Scrub Pine	Pinaceae	dry slopes
Plantago lanceolata L.	English Plantain	Plantaginaceae	1
Plantago rugelii Deene.	Plantain	Plantaginaceae	1
Plantanus occidentalis L.	Sycamore	Platanaceae	1
Polygonum pensylvanicum L.	Pinkweed	Polygonaceae	1
Polygonum persicaria L.	Lady's Thumb	Polygonaceae	1
Polygonum scandens L.	False Buckwheat	Polygonaceae	2
Populus deltoides Marsh.	Cottonwood	Salicaceae	1
Potentilla canadensis L.	Cinquefoil	Rosaceae	1
Prunus serotina Ehrh.	Black Cherry	Rosaceae	1
Prunus sp.	Cherry	Rosaceae	1
Pueraria lobata (Willd.) Ohwi	Kudzu Vine	Leguminosae	1
Quercus alba L.	White Oak	Fagaceae	4
Quercus coccinea Muench.	Scarlet Oak	Fagaceae	4

Latin Name	Common Name	Family	Habitat
Quercus falcata Michx.	Southern Red Oak	Fagaceae	4
Quercus meuhlenbergii Engelm.	Chinquapin Oak	Fagaceae	4
Quercus palustris Muench.	Pin Oak	Fagaceae	3
Quercus phellos L.	Willow Oak	Fagaceae	3
Quercus prinus L.	Chestnut Oak	Fagaceae	4
Quercus rubra L.	Red Oak	Fagaceae	4
Quercus velutina Lam.	Black Oak	Fagaceae	4
Rhus aromatica Ait.	Fragrant Sumac	Anacardiaceae	4
Rhus glabra L.	Smooth Sumac	Anacardiaceae	1
Rhus radicans L.	Poison Ivy	Anacardiaceae	1,4
Robinia pseudoacacia L.	Black Locust	Leguminosae	1
Rosa multiflora Thunb.	Wild Rose	Rosaceae	1,2
Rubus sp.	Blackberry	Rosaceae	1,2
Rudbeckia hirta L.	Black-eyed Susan	Compositae	1
Rumex obtusifolius L.	Broadleaf Dock	Polygonaceae	1
Salix fragilis L.	Crack Willow	Salicaceae	2,3
Salix nigra Marsh.	Black Willow	Salicaceae	2,3
Sambucus canadensis L.	Elderberry	Caprifoliaceae	1
Samolus parviflorus Raf.	Water Pimpernel	Primulaceae	3
Sassafras albidum (Nutt.) Nees.	Sassafras	Lauraceae	1

Latin Name	Common Name	Family	Habitat
Setaria magna Griseb.	Foxtail	Gramineae	3
Setaria viridis (L.) Beauv.	Foxtail	Gramineae	1
Sida spinosa L.	Prickly Mallow	Malvaceae	1
Smilax bona-nox L.	Greenbrier	Liliaceae	1
Smilax rotundifolia L.	Bullbrier	Liliaceae	1
Solanum carolinense L.	Horsenettle	Solanaceae	1
Solanum nigrum L.	Black Nightshade	Solanaceae	1
Solanum sarrachoides Sendt.	Nightshade	Solanaceae	1
Solidago petiolaris Ait.	Goldenrod	Compositae	1
Sorghastrum nutans (L.) Nash	Indian Grass	Gramineae	
Staphylea trifolia L.	Bladdernut	Staphyleaceae	4
Taraxacum officinale Wigg.	Dandelion	Compositae	1
Tilia americana L.	Basswood	Tiliaceae	4
Trifolium pratense L.	Red Clover	Leguminosae	1
Trifolium procumbens L.	Hop Clover	Leguminosae	1
Triodia flava (L.) Smyth.	Purpletop	Gramineae	1
Typha latifolia L.	Cattail	Typhaceae	3
Ulmus alata Michx.	Winged Elm	Ulmaceae	1
Ulmus americana L.	American Elm	Ulmaceae	1
Ulmus rubra Muhl.	Slippery Elm	Ulmaceae	1

Latin Name	Common Name	Family	Habitat
Verbesina virginica L.	Frostweed	Compositae	1
Vitis riparia Michx.	Riverbank Grape	Vitaceae	3
Vitis rotundifolia Michx.	Muscadine Grape	Vitaceae	1
Vitis rupestris Scheele	Sand Grape	Vitaceae	1
Woodsia obtusa (Spreng.) Torr.	Woods Fern	Polypodiaceae	4
Xanthium strumarium L.	Cocklebur	Compositae	2

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A. C. Skorepa
Department of Botany
University of Tennessee
Knoxville, Tennessee 37916

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7.0 HOLSTON RIVER - BUCK HOLLOW SITE

7.1 SITE DESCRIPTION

The site is located in Jefferson County, Tennessee, on the Holston River at mile 39L. It is approximately 5.5 miles northwest of Jefferson City, Tennessee.

The area covered by the site is approximately 1,570 ± acres of primarily pastureland, see Figure A7.0-1. Approximately 100 acres of the total area required for the exclusion area lie on the far side of the river. All of the land must be purchased.,

7.2 ACCESS FACILITIES

The Holston River is not navigable. The nearest point accessible by barge is at Knoxville, Tennessee, 20 ± air miles from the site.

Approximately four miles of new track will be required to connect the site with the Southern Railroad south of the site.

It will be necessary to construct approximately 0.5 mile of new road and improve 3.5 ± miles of existing road to connect the site with U.S. Highway 11E southeast of the site.

7.3 TRANSMISSION FACILITIES

A 161-kV (Cherokee Dam-Norris Dam) transmission line passes through the site. A second 161-kV (Cherokee Dam-Douglas Dam) transmission line passes 2 ± miles south of the site. Two 161-kV (John Sevier Steam Plant-Knoxville) transmission lines pass 3 ± miles north of the site. The 500-kV (Bull Run Steam Plant-Appalachian Power Company) transmission line passes 2.5 ± miles north of the site.

7.4 ENGINEERING CHARACTERISTICS

7.4.1 FOUNDATION CONDITIONS

Seismic investigation of the site indicates an overburden with an average thickness of 60 feet overlies the Copper Ridge Dolomite. The geologic report indicates the dolomite will be badly pinnacled with extensive weathering along joints and bedding planes.

7.4.2 SEISMIC CONDITIONS

A geologic map (1:250,000) shows a fault 2 ± miles southeast of the site. Two additional faults are shown 4 ± miles southeast of the site.

7.4.3 COOLING WATER

It has been found that during certain periods of the year, there will be an insufficient amount of make-up water available for cooling due to the operation of the Cherokee Reservoir.

7.4.4 FLOOD CONDITIONS

The general site grade will be approximately elevation 1,035. The preliminary maximum possible flood has been estimated at elevation 950.

7.4.5 SITE TOPOGRAPHY

Except for a narrow strip of flood plain along the western edge of the site, the terrain is rolling. Surface elevations vary from about 900 to 1,160.

7.5 POPULATION

The nearest population centers to the site are Jefferson City, Tennessee (population 5,100 ±, 5.5 ± miles southeast), Morristown, Tennessee (population 20,300 ±, 17 ± miles northeast), and Knoxville, Tennessee (population 174,600 ±, 23 ± miles southwest).

7.6 PROXIMITY TO RECREATION AREAS OR WILDLIFE REFUGES

None in the vicinity of the site.

7.7 CONCLUSIONS

Due to a probable undesirable foundation (see 7.4.1 above) and the problem of cooling water supply (see 7.4.3 above), this site will not be core drilled nor considered further as a potential site at this time.

Figure 7.0-1 BUCK HOLLOW SITE, HOLSTON RIVER MILE 39L

8.0 HOLSTON RIVER - LEE VALLEY SITE

8.1 SITE DESCRIPTION

The site is located in Hawkins County, Tennessee, on the Cherokee Reservoir at Holston River mile 88L. It is approximately 11 miles northeast of Morristown, Tennessee, and 10 ± miles southwest of Rogersville, Tennessee.

Area covered by the site is approximately 1,365 acres. A small portion of this area is within the boundary of the Cherokee Reservoir, see Figure A8.0-1.

8.2 ACCESS FACILITIES

The Holston River is not navigable. The nearest point accessible by barge is at Knoxville, Tennessee, 47 ± air miles from the site.

Approximately six miles of new track will be required to connect the site with the Southern Railroad, south of the site.

8.3 TRANSMISSION FACILITIES

Two 161-kV (John Sevier Steam Plant-Knoxville) and one (John Sevier Steam Plant-Cherokee Dam) transmission lines pass 2 ± miles north of the site. A 500-kV (Appalachian Power Company-Bull Run Steam Plant) transmission line passes 2 ± miles south of the site.

8.4 ENGINEERING CHARACTERISTICS

8.4.1 FOUNDATION CONDITIONS

Based on a reconnaissance of the site, the geologists believe the site is underlain by steeply dipping rock units of Ruthledge limestone

Rogersville shale, Maryville limestone and probably Nolichucky shale with overburden varying in thickness within the site, but generally thin over the shale and relatively thick over the limestone.

8.4.2 SEISMIC CONDITIONS

A geologic map (1:250,000) shows a fault (Rocky Valley) lies within the site area with three additional faults 0.5 mile, 1 mile and 1.5 miles north of the site.

8.4.3 COOLING WATER

Due to the seasonal fluctuation of the Cherokee Reservoir, the intake to the pumping station would be located approximately 8,000 to 10,000 feet from the site to take water from the old river channel.

8.4.4 FLOOD CONDITIONS

The general site grade will be approximately elevation 1,120. The preliminary maximum possible flood has been estimated at elevation 1,089.

8.4.5 SITE TOPOGRAPHY

The site lies in a relatively narrow valley which is flanked on both sides by high and rugged terrain. Ground surface elevations vary from about 1,070 in the valley to over 1,660 at some of the high ground summits in the general area.

8.5 POPULATION

Nearest population centers to the site are Rogersville, Tennessee (population 4,000 ±, 10 ± miles northeast) and Morristown, Tennessee (population 20,300 ±, 11 ± miles southwest).

8.6 PROXIMITY TO RECREATION AREAS OR WILDLIFE REFUGES

A Boy Scouts of America camp occupies a large portion of the site adjacent to the Dry Branch embayment. Additional facilities within ten river miles of the site include a TVA public use area, two commercial boat docks and eight boat launching sites.

8.7 CONCLUSIONS

Because of the questionable foundation (see Sections 8.4.1 and 8.4.2) no additional investigations will be made of this site at this time.

Figure 8.0-1 LEE VALLEY SITE, HOLSTON RIVER MILE 88L

9.0 PHIPPS BEND SITE

9.1 SITE DESCRIPTION

The Phipps Bend site is located in Hawkins County, Tennessee, on the right bank of the Holston River at HR mile 122, approximately 2.5 miles east of Surgoinsville, Tennessee. The site will consist of approximately 1,350 acres. The site is characterized by terrain variations of a flood plain along the east side, raising to a ridge of high ground on the west side. Surface elevations range from about 1,110 along the flood plain to over 1,260 at the peaks. Plant grade is estimated to be at elevation 1,175. See Figures A9.0-1 through A9.0-3 for locality map, reservation boundary map and aerial photograph.

9.2 ACCESS FACILITIES

Approximately one mile of new road and improvement of one mile of existing road will be required to connect the site with U.S. Highway 11W to the north.

A total of 1.5 miles of new track will be required to tie in with the Southern Railroad north of the site.

Since the Holston River is not navigable, barge access is not feasible.

9.3 ENGINEERING FEASIBILITY

9.3.1 SEISMOLOGY

The Phipps Bend site lies wholly within the Southern Appalachian Tectonic Province. In this province, which has experienced moderate seismic activity in the past, the maximum earthquake that has occurred in the province is assumed for design purposes to recur at the site. For this site the maximum earthquake would be the May 31, 1897, quake in Giles County, Virginia, which had a reported epicentral intensity of VIII on the Modified Mercalli scale.

9.3.2 HYDROLOGY

The Phipps Bend site is located on the Holston River at HRM 120-122. The Holston River is one of the major tributaries of the Tennessee River. The Holston River has a drainage of 3,776 square miles at its mouth and over 2,800 square miles above the proposed plant site at river mile 122.

Mean daily streamflow at the proposed Phipps Bend site is 3,600 cfs. Minimum daily flow at the site is about 800 cfs based on TVA's contractual agreements with Tennessee Eastman Company located on the South Fork of the Holston River. The natural 3-day, 20-year low flow in Tennessee in applying the water quality criteria to regulated streams is 815 cfs. For regulated streams the instantaneous minimum flow is used, which in all probability would be identified as the applicable streamflow at the Phipps Bend site. The minimum instantaneous flow recorded after closure of the Ft. Patrick Dam in 1953 but prior to the above contract was 485 cfs.

Flooding criteria present no limiting conditions at the Phipps Bend site although the site is only marginally acceptable.

9.3.3 GROUND WATER

The Phipps Bend site is located in a wide belt of Sevier Shale, which locally is a moderately productive aquifer capable of yielding up to 100 gpm to wells. Regionally, the most significant aquifer is the Knox Dolomite, which occurs in a belt to the north of the site. No other aquifers capable of yielding substantial quantities of water are known in the area.

Water occurs in the Sevier Shale in openings formed along fractures and bedding planes, some of which are solutionally enlarged. Drilling for foundation information at the site has not disclosed the presence of large open solution channels. Some cavities greater than one foot thick are present but nearly all are clay filled.

Ground water at the site occurs under unconfined (water table) conditions and is recharged by local precipitation. Water movement is from higher to lower topographic areas and discharge is to Holston River. Depths to the zone of saturation range from zero in a small area that may be a zone of perched water to a known maximum of 75 feet. Mean depth to water table, based on measurements in 44 exploration holes in May 1973, is 10 feet.

9.3.4 CLIMATOLOGY

Representative temperature data from the Rogersville, Tennessee, Cooperative Observer's Station show a mean annual temperature of 55.8 degrees F with the mean monthly temperature ranging from 35.2 degrees F in January to 73.8 degrees F in July. The highest temperature for the period of record (1887-1973) is 104 degrees F in June and the lowest is -18 degrees F in December, resulting in an extreme annual range of 122 degrees F.

The data show the greatest monthly average precipitation amounts occur in December-April and in July and the least in October. The extreme monthly maximum rainfall (at Rogersville) is 10.04 inches in March; the maximum 24-hour rainfall (at Rogersville) is 4.20 inches in June. Snowfall occurs mostly during December-March with an annual average of 9.2 inches.

The average annual relative humidity is 71.4 percent with the average monthly range from 63.5 percent in March to 78.0 percent in August. The six-hour diurnal distribution of the monthly average shows that the highest relative humidities occur at 0700 eastern standard time (EST) in July, August and September with respective values of 91, 92 and 91 percent. The lowest monthly average value of 51 percent occurs at 1300 EST in March and April.

Vertical temperature gradient measurements between 33 and 150 feet aboveground at the Phipps Bend site for the period December 19, 1973, through June 30, 1974, indicate surface-based inversions occurred about 37 percent of the total hours.

The National Weather Service data from the Bristol-Johnson City-Kingsport Station indicate that heavy fog (visibility equal to or less than one-fourth mile) occurs in the Phipps Bend site area about 43 days annually with a maximum monthly frequency of eight days in August and a minimum of one day per month in March and April.

9.3.4.1 METEOROLOGY

The Phipps Bend Nuclear Plant site is located in a flat open area on the north side of the Holston River. There are no appreciable ridges or mountainous areas within a mile of the temporary meteorological tower.

Wind measurements at 33 feet aboveground at the Phipps Bend site meteorological facility from December 19, 1973 to June 30, 1974, are used to describe the expected local wind patterns in the area. The Phipps Bend data indicate that the wind predominates from the west-southwest with secondary maxima distributed among northeast, southwest and north-northwest. A general southwest-northeast bimodal wind pattern is quite evident. The Phipps Bend wind data also show about 12 percent of the wind speed within the 0.6 to 1.4 mph range, 30 percent within the 1.5 to 3.4 mph range and 22 percent within the 3.5 to 5.4 mph range. About 5 percent of the data show calm conditions.

Atmospheric stability conditions at the Phipps Bend site are estimated from temperature measurements at 33 and 150 feet aboveground at the Phipps Bend meteorological facility. The data show that the Pasquill stability classes E, F and G occurred about 66 percent of the time. The most critical class, G, occurred about 8 percent of the time. The least stable classes, A, B and C, occurred about 7 percent of the time, while the neutral class, D, occurred about 27 percent of the time.

The most critical atmospheric dispersion condition, class G, 0.6 to 1.4 mph, occurred only 2.86 percent of the time with an additional 0.53 percent calm. Classes E and F had frequencies for the 0.6 to 1.4 mph and calm conditions of 4.94 and 2.31 percent for class E, and 3.36 and 1.89 percent for class F, respectively.

9.4 POPULATION

Nearly 18,000 people live within 10 miles of the Phipps Bend site, with over 70 percent of the population between 5 and 10 miles. Two small towns, Mount Carmel and Church Hill, are located between about 6 to 9 miles and 9 to 12 miles, respectively, from the site. Their combined 1970 population was 5,643 with 55 percent living in the 5- to 10-mile area. The growth in and around these two places is expected to account for a substantial portion of the growth in the 10-mile radius. The remaining area is sparsely settled.

Although there are no major urban concentrations (a population of 50,000 or more) within 50 miles of the site, there are six small population centers (a population between 10,000 and 50,000). To the east-southeast are Johnson City (population 33,770) and Elizabethton (population 12,269), located between about 31 and 36 miles, respectively, from the site. Kingsport (population 31,938) is to the east-northeast (with a very small amount to the east) between about 11 and 19 miles. The two Bristols, located in Tennessee and Virginia (combined population of 34,921 in 1970), are also to the east in the 30- to 40-mile sector. To the west-southwest and southwest is Morristown (population 21,318), between about 26 and 36 miles. Greeneville (population 13,722) is to the south between about 18 and 23 miles. Nearly 80 percent of the population growth to the year 2000 is expected to occur in and around these population centers.

9.5 ENVIRONMENTAL CHARACTERISTICS

9.5.1 LAND REQUIREMENTS

It is estimated that the total acreage required for the Phipps Bend site is approximately 1,350. TVA has not as yet acquired ownership of the Phipps Bend site.

9.5.2 LAND USE CHARACTERISTICS

The land use in the area surrounding the Phipps Bend site is generally characterized as agricultural in use with associated low density housing. However, there is a marked tendency toward industrial usage as evidenced by the location of several large industrial facilities within 10 miles of the plant area. The Alladin Plastic Co. is located north of the plant exclusion zone.

9.5.3 RECREATION

There are no known major recreational developments proposed in the vicinity of the site and only two intensive use areas presently exist within 10 miles of the site. These areas consist of a campground/park--Greenland Park and Campground (annual visitation - 22,000) and a swimming pool - Silver Lake Swimming Pool (annual visitation - 30,000).

No other factors of significance or uniqueness in either land use or character were identified at the site. Some dispersed use is made of this section of the Holston River for such activities as canoeing, fishing and hunting. This use is estimated at 4,000 visits per year, for a total visitation of 56,000 to all recreation areas within 10 miles of the site.

9.5.4 ARCHAEOLOGICAL SIGNIFICANCE

The Phipps Bend site was surveyed by Dr. Major C. R. McCollough in January 1973, see Appendix I to Section 9.0. The preliminary archaeological assessment survey indicated seven archaeological sites and five surface indications of prehistoric sites. Because most of the area surveyed was in dense ground cover, a thorough examination of the area was not possible.

9.5.5 HISTORICAL SIGNIFICANCE

Based on a 1973 review of the site by the State Historical Commission, no historic buildings or areas were identified either within or in close proximity to the site boundary. In a 1974 review of the "National Register of Historic Places" (the most current information available on the Tennessee Plan for historic preservation) and a listing of Tennessee historical markers, no historic structures or sites were identified within the plant site. There is a National Register property located approximately one mile north of the plant site at Stony Point. Another National Register property, a house known as Long Meadow, is located about 3 to 4 miles northwest of the plant site. Neither of these should be adversely affected by the proposed facility.

9.6 ECOLOGY

An ecological survey report is attached as Appendix III to Section 9.0.

9.6.1 FISHERIES AND WILDLIFE

The Holston River at the Phipps Bend site is characterized by low river flow. Preliminary sampling indicates that larval fish concentrations are low; however, the percentage of total larval fish potentially entrained would probably be high. Potential for damage to the fishery resource in the Holston River and John Sevier Reservoir is high. Flow augmentation from Fort Patrick Henry Dam might reduce the potential for damage.

9.6.2 WILDLIFE

Investigations thus far have revealed the presence of several unique faunal elements. Nesting Virginia rails have been found at Phipps Bend during the spring 1974 studies. Also, Willow fly catchers were found nesting in riparian vegetation along the Holston River. This bird normally is not found nesting at this latitude as it is a more northerly species.

The section of river between the Holston Ordinance Plant and John Sevier Steam Plant supports some of the highest concentrations of wood ducks the state and is classified as the best wood duck area in east Tennessee. The Phipps Bend area also provides good habitat for shore birds.

Development of a nuclear plant at Phipps Bend will not have a significant impact on local or regional terrestrial ecosystems. The fact that unique species exist on the site cannot be considered categorically adverse. In fact, some unique species derive benefit from existing within an exclusion zone.

9.7 CONCLUSION

This site is currently receiving active consideration by TVA for commercial application.

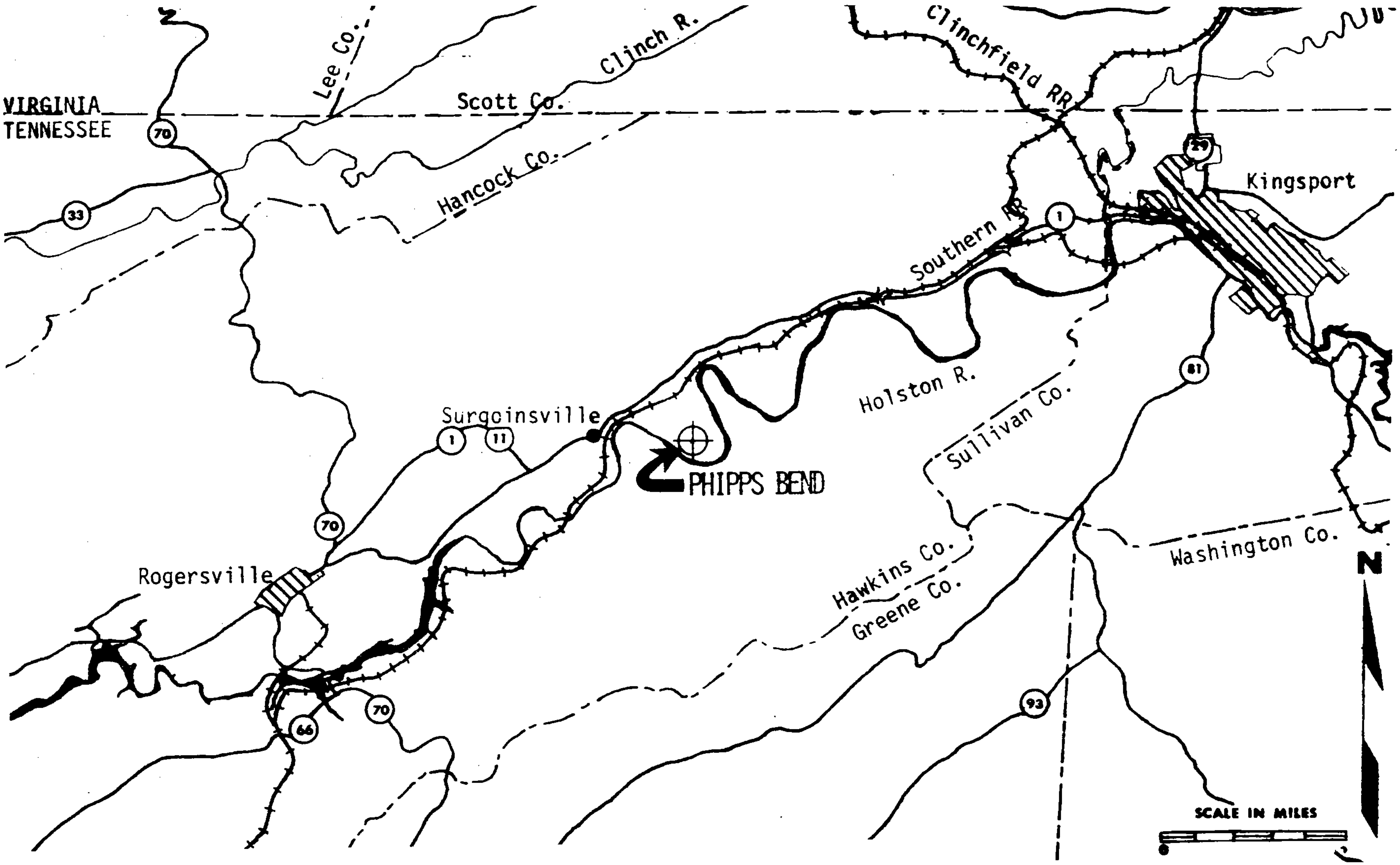

Figure 9.0-1 LOCALITY MAP, PHIPPS BEND SITE

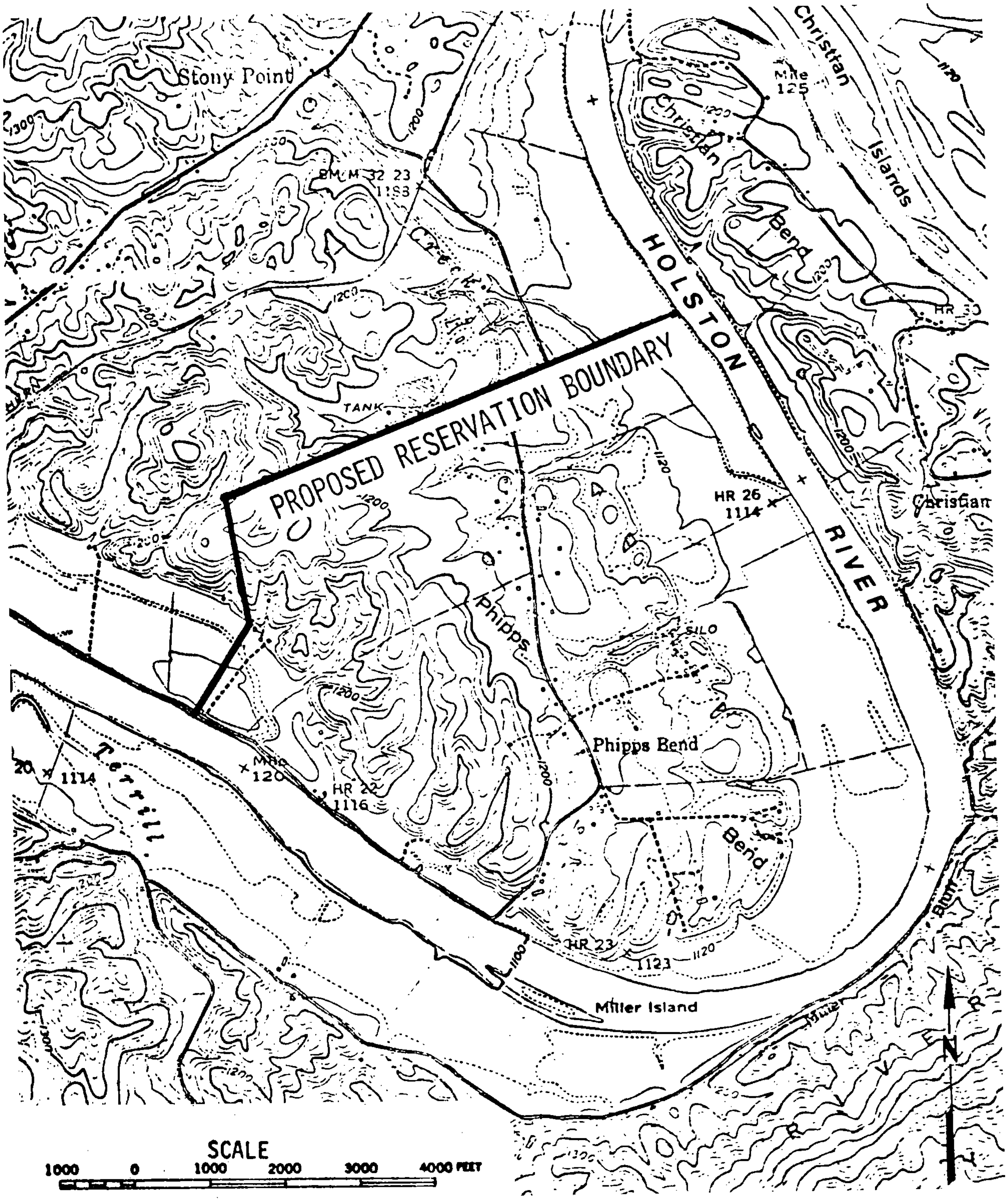

Figure 9.0-2 PROPOSED RESERVATION BOUNDARY MAP, PHIPPS BEND SITE

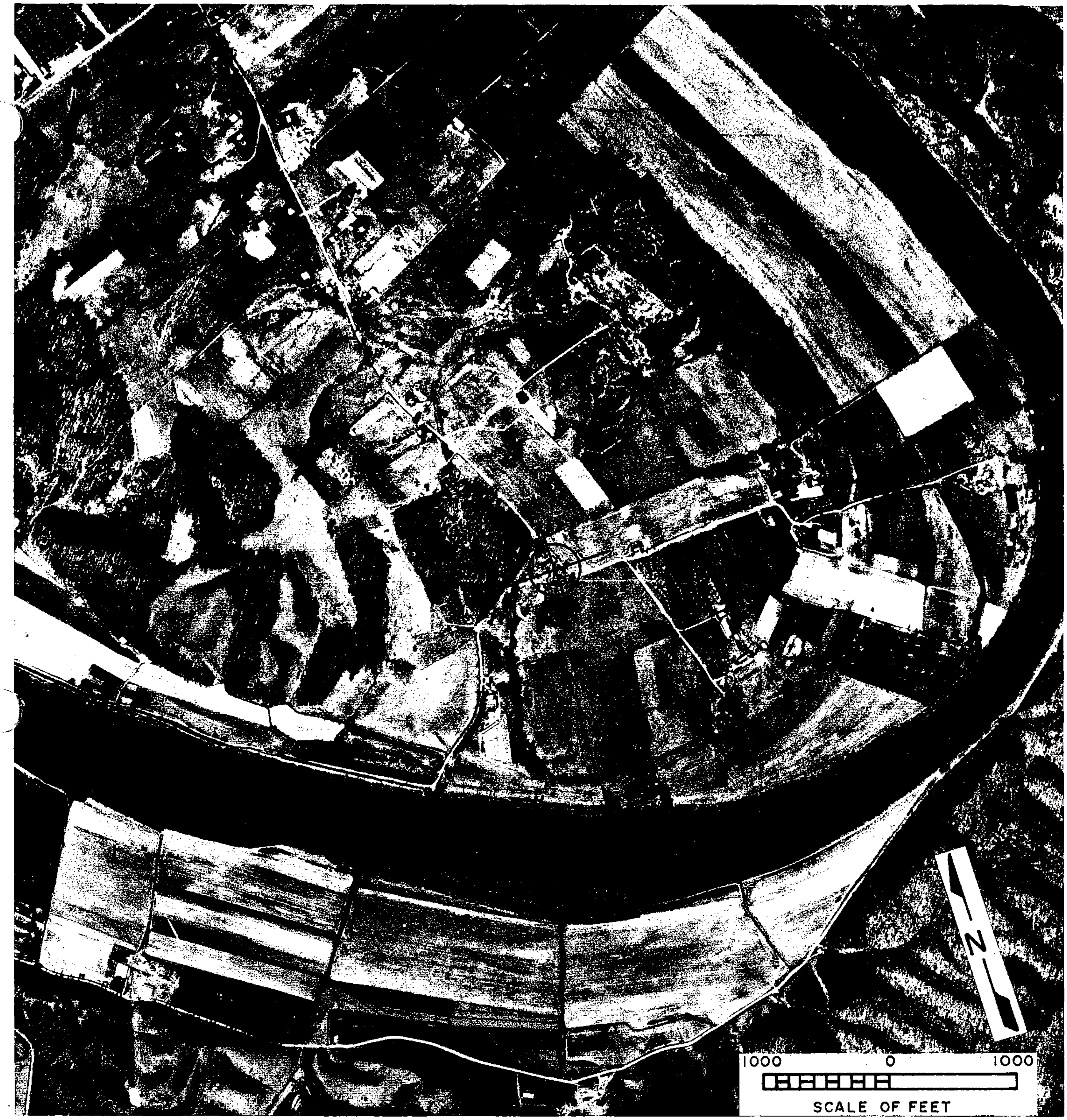

Figure 9.0-3 PHIPPS BEND SITE, HOLSTON RIVER MILE 122R

APPENDIX I TO SECTION 9.0

OF

APPENDIX A

ARCHAEOLOGICAL SURVEY REPORT

PHIPPS BEND SITE

ARCHAEOLOGICAL SURVEY OF THE PHIPPS BEND STEAM PLANT SITE ON THE HOLSTON RIVER NEAR SURGOINSVILLE, HAWKINS COUNTY, TENNESSEE

Dr. Major C. R. McCollough
Research Assistant Professor
Department of Anthropology
The University of Tennessee

Conducted for the Tennessee Valley Authority
in Accordance with Contract TV-36493A

February 15, 1973

ABSTRACT

On January 21 and 27, 1973, Dr. Major C. R. McCollough and two trained field assistants conducted an intensive surface survey of the Phipps Bend steam plant site for the purpose of locating and evaluating archaeological sites and historic features which would be affected by steam plant construction and operation in this area; the survey party was filled on January 21 by Mr. Lloyd N. Chapman and Mr. Howard Earnest, Jr., and on January 27 by Mr. Chapman and Mr. Stanley Z. Guffey. Seven archaeological sites and five relatively minor surface indications were encountered, and these are located on relatively low-lying terraces around the perimeter of the larger plant exclusion circle. Surface collections from these sites, described in the following report, are stored in the Department of Anthropology, The University of Tennessee.

The central area of the Phipps Bend plant site comprises the moderately populated rural settlement of Phipps Bend, the North-South road along which the structures of the settlement are clustered, and the agricultural land immediately surrounding the settlement, all of this on a high but broad and level terrace above the Holston River (Figure 1). The larger plant exclusion area extends to include other relevant topography to the West and East; in the former case, sharply-dissected terrain at the highest elevations represented in Phipps Bend, and in the latter, the broad level second terrace of the Holston, marked by a foreslope with very sharp relief.

The methodology and terminology employed in the conduct and reporting of the Phipps Bend survey are those which have been described in detail in an earlier and entirely comparable report (McCollough n.d.: 1-3). <u>All</u> available surface exposures in the steam plant area were investigated in the course of the survey, and these included:

a. Plowed fields, stands of corn, and lightly sodded fields in bottom land on the West side of Phipps Bend adjacent to an area of limestone shoals in the Holston River (Clamon-Rhoton farm).

b. Cultivated areas on the dissected middle terraces in the South sector of the exclusion area--Dobbs, Christian, Patterson, Britton properties; permission for survey on Christian property in the Southeast sector was denied, in absence of permit.

c. Gardens, tobacco patches, cattle paths, and recently extensively cleared wooded areas at high elevations in the West sector of the exclusion area--Burton, Dobbs, Arnott, Baines, Manis, Clamon-Rhoton properties.

d. All gardens, tobacco patches, barnyards, unpaved roads, and stream gullies concentrated around the road and dwellings in the central plant area--all property owners except Clamon-Rhoton.

e. All exposures in the relatively large second-terrace fields in the East sector of the exclusion area, ending at the riverward edge of the second terrace--Arnott property.

Permanent pasture cover was predominant in the central plant area and only a few of the locations which could be surveyed there constitute favored locations for prehistoric occupation (level areas above small streams which flow across the terraces, riverward terrace rims, etc.). Nonetheless, the central plant area occupies a high terrace on which intensive prehistoric occupation might not be expected. As was anticipated, the residents of Phipps Bend (including a collector/pot-hunter of the most uninformed order) reported that whereas stray finds only had been recovered from the plant exclusion area, the lower terraces East of the plant had yielded "pickup truck loads" of prehistoric artifacts and a "graveyard site." At the time of the survey, these bottom fields lay almost exclusively in permanent pasture and could not be investigated effectively. The contents of the local collection corroborated the existence of a rich site which has yielded numerous late prehistoric/historic Indian burials to collectors, who have reportedly used a backhoe in their work. This site has previously been located on state survey records (University of Tennessee n.d.--no additional data available) and lies on the floodplain adjacent to the right bank of the Holston River at mile 123 (J.C. Jones property), just North of the mouth of Stony Point Creek (Figure 1), and has almost certainly been destroyed. Only one site (40HW36) was encountered in the East-bottom fields during the survey--this in the single small field which is currently under cultivation in the relevant area; Site 40HW36 will be described below. Should disturbance be effected by plant construction or operation on the first and floodplain terraces East of the exclusion circle, destruction of major archaeological data can be anticipated with certainty.

Absolutely no trace of prehistoric occupation was encountered in the central plant area, but, given the limitations of surface survey techniques and the predominance of heavy vegetational cover in the zone, the statement does not connote that no such evidence exists here. Likewise, no occupational evidence was found in large open areas at high elevations in the West sector of the exclusion circle. Two potentially important sites (40HW34 and 40HW35) were found within the northeastern limit of the exclusion circle, on the riverward rim of the imposing second terrace (Arnott property). The additional five sites and five surface indications documented in this report are situated on first and second terraces around the periphery of the exclusion circle; these locations will be effectively isolated in the toe of the Phipps Bend peninsula upon construction of the plant, and full details for the sites are presented below, against possible effects on any or all of them due to plant construction and operation.

Four noteworthy historic features were encountered by the survey party. A small modern cemetery, not indicated on topographic maps, was found high in the West sector of the exclusion circle, 1300 feet WNW of the Phipps Bend Freewill Baptist Church and 350 feet WNW of a small frame barn at the rear of the property owned by Nora Baines et al. (Figure 1); it thus probably pertains to the Clamon-Rhoton farm. The 50' x 50' fenced plot apparently contains ca. 20 interments, with headstones on only 10-15 of the graves; dated gravestones indicate that the cemetery was in use from 1930-1960. Surface indications of a razed house and associated features were encountered just inside the Northeast limit of the exclusion circle on the James Arnott property, in close proximity to prehistoric sites 40HW34 and 40HW35. The house was constructed prior the Civil War, purchased by Arnott's father ca. 1905, and razed ca. 1968 (James Arnott, personal communication). Because the proximity of the house rubble to site 40HW34 presents a problem of interpretation, more will be said of the historic feature below, where data for the prehistoric site are presented in full. Little can be reported regarding the construction of the house, except that it was a brick structure with a crude limestone foundation measuring ca. 18' x 50' (long axis NW-SE). Although many impressive and finely-preserved early historic log and brick structures are to be found in the Surgoinsville area, the only other notable historic buildings in the plant locality pertain to the C. B. Britton farm at the South end of Phipps Bend, outside the South sector of the exclusion circle. The main house on the Britton farm has a well-preserved log

log section at its rear, on the edge of the second terrace, and brick rubble found at a spring location at the rear of the first terrace, 800 feet East of the house, suggests that a substantial brick spring-house or other structure related to the Britton complex stood here (Figure 1).

The seven prehistoric sites and five minor surface indications discovered during the January, 1973 survey of the Phipps Bend steam plant site are documented below in the order most convenient for a discussion of their status and potential.

Site 40HW31

36°27'54"N.Lat., 82°49'24"W.Long., elevation 1120'AMSL

This site is located on a front lobe of the broad first terrace on the Clamon-Rhoton farm, near the river channel on the right bank opposite mile 120, just Southeast of the mouth of a small stream, and adjacent to an unpaved road which parallels the river bank (Figure 1). A moderate surface scatter of material was encountered here in a 150' x 300' area within a plowed field; most of the material was concentrated on the Northwest rim and foreslope of the 1120' terrace where it falls toward the stream channel, possibly indicating only that the most active erosion of a buried midden is occurring there. The presence of a Middle/Late Archaic hunting and butchering station is indicated by the surface collection (N=32):

Projectile points/knives	
Large straight stemmed	-1
Small contracting stemmed	-1
Small slightly expanding stemmed, convex base	-2
Small side notched	-2
Scrapers	
Side, uniface	-1

<u>Bifaces</u>	
Segment, large quartzite biface, cf. Appalachian stemmed	-1
Fragments	-4
<u>Chopper</u>, quartzite	-1
<u>Flakes</u>	
Misc. retouched	-1
Unretouched	-15
<u>Cores</u>	
Amorphous	-1
<u>Palette</u>, fine-grained sandstone--ground	-1
<u>Net sinker</u>, sandstone cobble--possible	-1

Surface Indication 4

36°27'58"N.Lat., 82°49'25"W.Long., elevation 1120'AMSL

Surface Indication 4 is a small locus (40 feet in diameter) situated 300 feet directly North of site 40HW31, on the same terrace and plowed field and equally near the small stream channel (Figure 1). Debris on the surface consists of a few small flint flakes, and it is tentatively suggested that this is a small Archaic flint-knapping floor related to the large site immediately to the South.

Site 40HW32

36°27'51"N.Lat., 82°49'21"W.Long., elevation 1120'AMSL

This site, 75' x 75' in apparent extent, is centered 200 feet Southeast of the eastern fringe of site 40HW31; on another lobe of the same terrace in the plowed field; 300 feet Northwest of the Rhoton house; and within 200 feet of the right bank of the Holston River (Figure 1). The surface presents a moderate concentration of fire-cracked quartzite and a low density of artifactual remains in the small area; a Late Archaic or Woodland attribution is advanced, the latter being more likely, but it is impossible to assess settlement type on the basis of the small surface collection (N=6). An undisturbed midden deposit is probably present in this area.

<u>Projectile points/knives</u>	
Fragment, indeterminate	-1
<u>Wedge</u>, splintered (wood- and bone-working)	-1
<u>Flakes</u>	
Unretouched	-1
<u>Cores</u>	
Amorphous	-1
<u>Nutstone</u>, quartzite	-1
<u>Mussel shell</u>, fragment	-1

Site 40HW33

36"27'37"N.Lat., 82°48'43"W.Long., elevation 1180'AMSL

Site 40HW33 is a small Woodland occupation locus situated high on a dissected finger of the bluff 800 feet Northeast of the right bank of the Holston at mile 120.75 (Figure 1). It lies in a small garden plot (75' x 75') immediately South of the Ray Dobbs house and may extend beneath that structure; the Phipps Bend road passes just West of the site, and a former spring is situated between the site and the road. The location is 300 feet outside the SW quadrant of the plant exclusion circle. A Woodland attribution is advanced on the basis of a single ceramic sherd, the additional yield from the surface scatter being small and fragmentary (N=23). The presence of an undisturbed midden is very strongly suspected, and the site could yield important Woodland data, particularly in view of its unusually high spring-oriented location on the bluffs. A short testing program is recommended for 40HW33 since plant construction, should it involve only razing of the Dobbs house, is considered to directly threaten the site.

Projectile points/knives	
Stem fragment	-1
Distal fragment	-1
Segment	-1
Bifaces	
Thick, amorphous	-1
Flakes	
Misc. retouched	-1
Unretouched	-17
Ceramics	
Grit-tempered residual body sherd	-1

Site 40HW30

36°27'33"N.Lat., 82°48'18"W.Long., elevation 1160'AMSL

This site is located on the C. B. Britton farm just Southeast of the plant exclusion circle. It lies atop and well back on the second terrace; 400 feet Northeast of the main Britton house and 1100 feet North of the right bank of the Holston at mile 121.3 (Figure 1). The site covers an area approximately 75' x 100' (long axis East-West) adjacent to the South wall of the large barn on the Britton property and probably extends northward beneath the building. Materials recovered from a moderate surface scatter in the garden plot at this location denote a (Middle?) Archaic occupation (N=28). A short testing program is recommended for this site if it is to be affected by activities attendant to plant construction, including razing of the barn by heavy equipment.

Projectile points/knives	
Basal notched	-1
Weak side notched	-2
Stem fragment	-1
Scrapers	
Side	-1
Hollow side (spokeshave)	-1

Bifaces	
Small ovate	-1
Small amorphous	-5
Notched flakes	-1
Flakes	
Misc. retouched	-4
Unretouched	-9
Cores	
Amorphous	-1
Worked slate	-1

Surface Indication 1

36°27'32"N.Lat., 82°48'16"W.Long., elevation 1155'AMSL

Surface Indication 1 comprises a light scatter of surface material in a band 75' long (North-South) and 50' wide, centered one hundred fifty feet Southeast of site 40HW30 (Figure 1). This location is on a gentle slope between the highest elevation of the second terrace and the main riverward rim of that feature. The surface collection from Surface Indication 1 (N=6) consists of a cf. Palmer corner-nothced and serrated projectile point and five unretouched flakes, suggesting the existence of an Early Archaic station. The surface material could represent an extension of site 40HW30 or a derivative context, to which the material has washed from the larger site above; testing should not be required.

Surface Indication 2

36°27'35"N.Lat., 82°48'17"W.Long., elevation 1160'AMSL

Surface Indication 2 occupies an area roughly one hundred feet in diameter and is situated in the triangle formed by three barns on the Britton property, 200 feet NNE of site 40HW30 on the same high ridge of the second terrace above the Holston (Figure 1). The moderate surface scatter (N=20) recovered from this area, most recently planted in corn, includes:

<u>Projectile points/knives</u>	
Fragments: proximal, indeterminate	-1
dismal, indeterminate	-1
<u>Flakes</u>	
Misc. retouched	-3
Unretouched	-15

The occupation represented by Surface Indication 2 is tentatively ascribed to the Archaic period, and further to the Late Archaic because none of the relatively clear diagnostic indicators of earlier attribution was found; testing is not indicated.

Surface Indication 3

36°27'36"N.Lat., 82°48'14"W.Long., elevation 1160'AMSL

This is a manifestation similar to Surface Indication 2, likewise tentatively diagnosed as a Late Archaic station; it occupies an area one hundred feet in diameter and lies 200 feet Northeast of Surface Indication 2 in the same ridge-top cornfield on the Britton farm (Figure 1). The surface collection from Surface Indication 3 (N=13) comprises:

<u>Projectile points/knives</u>	
Fragments: segment	-1
<u>Flakes</u>	
Misc. retouched	-1
Unretouched	-9
<u>Cores</u>	
Amorphous	-1
Core rejuvenation flake	-1

Testing is not specifically recommended in this case; however, should testing and/or excavation be undertaken on site 40HW30 in anticipation of its destruction, a limited effort involving test excavations should be made to determine the relationship between the site and the nearby cluster of surface indications (1, 2 and 3).

Site 40HW34

36°28'05"N.Lat., 82°48'16"W.Long., elevation 1140'AMSL

This site is located within the Northeast quadrant of the plant exclusion circle, just behind the bold riverward edge of the second terrace above the right bank of the Holston at mile 122.6, and 1900 feet West of the river bank on the James Arnott property (Figure 1). It lies in a tobacco field 300 feet East of a large abandoned stable on the Arnott farm and at the East end of an unpaved lane which formerly led from the stable to a house at the edge of the terrace. The site is represented by a moderate surface scatter in a 50' x 150' area with its long axis paralleling the edge of the terrace. At the North end of the site area lies a similarly-oriented rectangular sand-filled depression (measuring 18' x 50') which represents the razed Arnott house; the slightly-depressed area contains a small quantity of brick rubble and a few limestone foundation blocks; modern trash from the house, including brickbats, ceramics and bottles, is scattered throughout the site area and more widely in the tobacco field. With the exception of two bottle fragments and a few historic sherds which could pre-date 1900, all of this trash is attributable to twentieth century occupation of the house. Mr. James Arnott (personal communication) furnished the following essential details of the history of the house, sought because a problem of contextual interpretation was raised by the juxtaposition of historic and prehistoric features and artifacts on the surface.

About 1905, Arnott's father purchased the brick house, which had been constructed before the Civil War. Soon after James Arnott's birth, probably in the 1920's, the family moved to Surgoinsville, but they have retained the property to the present; presumably the house was rented until it became unfit for occupancy (ca. 1968) and then was razed. Most of the ruined structure was deposited, as a safety precaution, in a well shaft which lies approximately fifty feet behind (East of) the house location just below the brow of the terrace and above a former spring. The bulky remainder of the rubble was pushed eastward off the house site to the rim of the terrace, and the smaller debris has since been spread over the area surrounding the house by plowing for tobacco cultivation.

The distinctive nature of the prehistoric artifacts initially recovered by the survey party at this locus, and their spatial relationships with the ruined house, raised the suspicion that they had been collected elsewhere in the Phipps Bend locality by a farmer or casual collector, stored in the house, and moved to their present positions on the surface by the house demolition process and subsequent plowing.

A grooved dolomite axe, referable to the Archaic period, was found just outside the Northeast corner of the house depression, a large quartzite maul just outside the Southwest corner, and two bi-pitted anvil/hammerstones in the sandy fill of the depression itself. Stone axes (with unbroken projectile points and certain other artifacts) are commonly noticed on the surface and collected by casual observers. Pitted anvil stones, although symmetrical in form and extensively modified from natural cobble morphology, are less likely to have been collected casually, and the large quartzite maul is definitely not a "collectable." The material initially found at the house site, although homogeneous in terms of probable Archaic attribution, could nevertheless not certainly be interpreted as other than a farmer's collection. Mr. Arnott could not identify the recovered material or shed further light on the problem of interpretation.

A second investigation of the area produced ample evidence of an Early/Middle Archaic site, as initially described in this treatment. Flint knapping debris and fragmentary projectile points and bifaces (including a crude Early Archaic bifurcated-base point)--none of which can be considered to have been casually collected--were found in the area immediately surrounding the house depression on all sides and extending southeastward from the house in a band 100 feet long and 50 feet wide along the edge of the terrace. The heavy tools initially recovered in close proximity to the house are still not ruled out as collected items, but their "fit" with the Archaic materials from the overall area of site 40HW34 which are definitely in place, and the fact that the house depression definitely lies with the boundaries of the prehistoric site, weaken the easy explanation based on a "farmer's" collection".

The total prehistoric surface inventory from site 40HW34 (N=29) comprises the following:

Projectile points/knives	
Bifurcated-base	-1
Side notched (fragmentary)	-2
Rounded stemmed (fragmentary)	-1
Bifaces	
Fragments	-3
Wedge, splintered	-1
Flakes	
Misc. retouched	-4
Unretouched	-9
Cores	
Amorphous	-1
Unworked block	-1
Pitted Anvil/hammerstones, quartzite	
Pitted both faces	-2
Pitted one face	-1
Grooved Axe, dolomite	-1
Maul, quartzite cobble	-1
Bone	
Burned long bone fragment (mammal)	-1

Site 40HW34 is in fact on a very favorable location which combines the well-drained commanding edge of the second terrace, with sharp relief giving onto the bottoms immediately to the East, a spring (captured in historic times by the Arnott well) which issued from the foreslope of the terrace at this point, and a stream valley 800 feet to the North. Other archaic manifestations in analogous locations (Site 40HW35 and Surface Indication 5, described below) suggest that similar sites may exist in an almost continuous distribution along the terrace edge. Permanent pasture cover on most of the terrace rim made it impossible to test this hypothesis fully by means of surface survey; beyond the specific recommendations made for testing the two sites which <u>were</u> documented in this favored zone, it is strongly urged that a testing program be undertaken in any portion of the second terrace rim at the eastern limits of the plant exclusion area, for which earthmoving or other major disturbance may be proposed.

The presence of an undisturbed midden deposit is suspected for site 40HW34, and the site contains data from an early temporal horizon which has rarely been investigated by means of controlled excavations. For these reasons, and because 40HW34 (with 40HW35) is the most likely of all sites encountered to be immediately threatened by plant construction, highest priority for testing and possible excavation is given to these sites.

Site 40HW35

36°28'07"N.Lat., 82°48'17"W.Long., elevation 1140'AMSL

This site is centered three hundred feet Northwest of site 40HW34 in the same tobacco field on the James Arnott property; its position on the riverward edge of the second terrace is analogous to that of 40HW34, and it moreover commands the small stream valley immediately to the North (Figure 1). The site is represented by a moderate scatter of lithic material in a 75' x 100' area (long axis NW-SE, paralleling the edge of the terrace), and an Archaic occupation, roughly contemporary with that of site 40HW34, is indicated. A small amount of twentieth century material from the nearby Arnott house was also found in this area, with a single green feather-edge sherd (ca. 1820-1840) which constitutes the earliest historic surface indication on the old Arnott homestead. The surface collection of prehistoric artifacts from site 40HW35 includes (N=47):

Projectile points/knives	
Small side notched serrated (Early Archaic--Palmer variant?)	-1
Small side notched	-1
Side notched fragment	-1
Small stemmed	-1
Corner notched fragment	-1
Distal fragments	-2
Segments	-3
Flakes	
Misc. retouched	-2
Unretouched	-28
Cores	
Amorphous	-7

Differentials in the artifact-class composition of materials from sites 40HW34 and 40HW35 suggest that they may in fact be spatially and functionally segregated areas of a single occupation zone of "site." The presence of an undisturbed midden is suspected for site 40HW35, and it is given highest priority for testing and possible excavation, for the reasons detailed in the treatment of site 40HW34.

Surface Indication 5

36°28'18"N.Lat., 82°48'26"W.Long., elevation 1155'AMSL

This surface indication consists of a stray find (bifacial perforator or drill fragment) recovered from the East-West road which separates the James Arnott and J. C. Jones properties, at the point at which the road cuts through the bold riverward rim of the second terrace (Figure 1). This position is entirely analogous to that of sites 40HW35 and 40HW34, located 1250' and 1550', respectively, to the Southeast on the brow of the terrace, and points up the contention that the entire terrace front, little of which could be surveyed because of heavy sod cover, can be expected to yield a nearly-continuous distribution of occupation loci, attributable primarily to the Archaic period. Testing is not recommended for the Surface Indication 5 location itself, but it is again strongly urged that a test program employing random sampling techniques be carried out on any segment of the eastern second terrace rim which is to be damaged by construction activities. Such a program could be facilitated by longitudinal plowing and controlled surface collection on the terrace rim prior to excavation, to test the hypothesis which ascribes numerous occupation loci to the rim zone.

Site 40HW36

36°28'21"N.Lat., 82°48'20"W.Long., elevation 1130'AMSL

This site, located on a small hummock in the middle of the broad first terrace above the right bank of the Holston at mile 123, was the only one encountered on the bottom terraces, by virtue of location in a cornfield in an otherwise densely-sodded context. It lies on the J. C. Jones property immediately North of the property line with James Arnott; 1600' West of the river bank and 1400' Southwest of the "cemetery" site at the mouth of Stony Point Creek; and 900 feet outside the Northeast quadrant of the plant exclusion circle (Figure 1). The small site area (ca. 75' x 75') is littered with a moderate concentration of fire-cracked stone, and it yielded the following artifactual material during a brief surface reconnaissance (N=20):

Projectile points/knives	
Crude spike point	-1
Perforators	-1
Wedge, splintered	-1

<u>Flakes</u>	
Misc. retouched	-1
Unretouched	-14
<u>Cores</u>	
Amorphous	-1
<u>Hammerstone</u>	-1

A (probably Late) Woodland occupation and the presence of an undisturbed midden deposit are suspected, although no pottery was recovered. Testing will not be required on the site unless unforeseen activities related to plant construction and use are to affect its specific location. The existence of the site does, however, evoke the recommendation that, if such plant-related construction, grading, trenching, etc. are to intrude on the first and floodplain terraces outside the exclusion circle and above the right bank of the Holston between miles 123 and 121, a testing program be undertaken for the areas or rights-of-way which are to be affected. The reports of the local residents that the bulk of prehistoric evidence is to be found on these low terraces are probably correct; relatively large and recent (Woodland and Mississippian) sites could be numerous here, and are most likely to be located on elevated areas above stream channels and dissected lobes of the terrace terrain. Although large and productive of more material than Archaic sites within the plant area proper on the high second terrace, these occupation areas are not likely to have been year-round or permanent base camps because flooding approaching the modern maximum probable level (1137') would have inundated or effectively isolated them.

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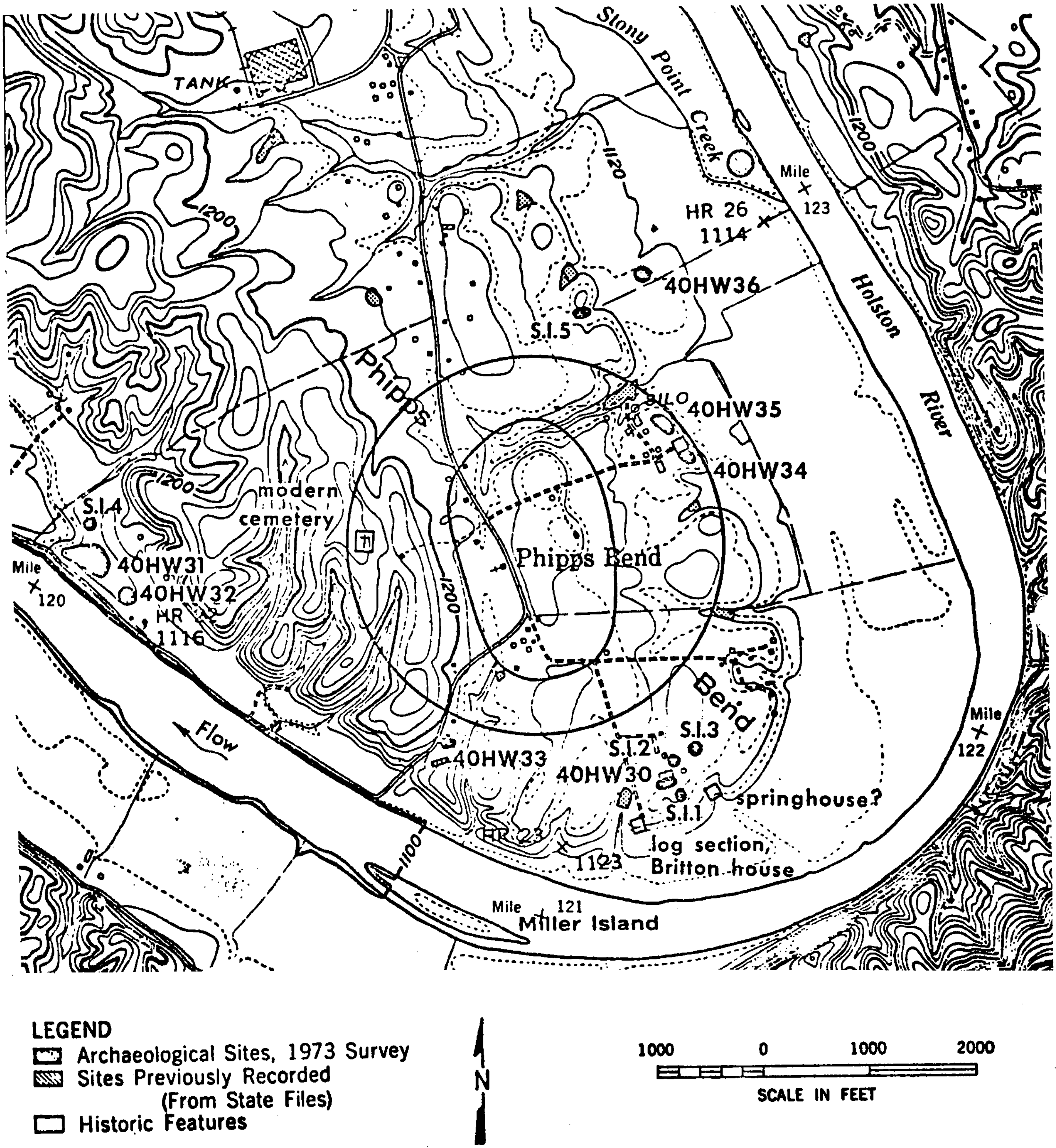

Figure 1 PHIPPS BEND SITE -- KNOWN ARCHAEOLOGICAL RESOURCES, 1973

APPENDIX II TO SECTION 9.0

OF

APPENDIX A

ECOLOGICAL SURVEY REPORT

PHIPPS BEND SITE

Phipps Bend

Vegetation

The Phipps Bend site, located on the Holston River in Hawkins County, Tennessee, is characterized as an area of small farm agriculture. Approximately 84 percent is open land which is utilized (or has recently been utilized) in agricultural endeavors; the remaining 16 percent is wooded. Water on the site is contained in several small farm ponds and 12-15 creeks, many of which are dry during the summer months. The elevation varies from 1,100 feet at the river's edge to 1,300 on the ridge tops.

Land use at the site is as follows:

Use	Acreage
Forest	230
Pasture	600
Cultivated	530
Other	55
Total	1,415

Open land may be further categorized as cultivated, pasture, old field, or river border.

Open Land

Cultivated land--Cultivated land is primarily in corn, tobacco, or hay. Most hay crops are timothy, orchard grass, and clover. Some hay fields, although harvested, have been poorly tended and are heavily invaded by weed species (ragweeds, bush clover, asters, bidens). A few fields have remained uncut and are replete with the above mentioned species plus goldenrod, violets, and wingstem.

Pasture--Of the open land available, most (approximately 40-50 percent) is devoted to pasture. Pastures exhibit considerable variability, most of which is a function of the degree of usage by livestock, time since last grazed, and elevation-distance from the river-soil moisture. Dominant species appear to be Dallis grass, fescue, orchard grass, lespedeza, and clover. In several pastures there are low, poorly drained areas which are floristically interesting, but make little contribution to the overall ecology of the area.

Old field--Some pasture land has been left ungrazed for a sufficient length of time to permit successional advancement. These few areas are characterized by broomsedge, asters, and thistle.

River border--The river water level fluctuates so as to create a transitional zone sufficiently well drained to be occupied by terrestrial, although hydrophyllic species of a density warranting this separate classification. Most apparent in this border strip is wingstem, jewelweed, poison hemlock, boneset, joe-pye weed, and marsh purselane.

Forest Lands

Of the total 230 acres of woodland, approximately 128 acres contain merchantable timber. All wooded lands are mixed hardwood with the exception of 15 acres in small stands of cedar-hardwood, pine-hardwood, and Virginia pine. Almost all wooded areas have been open to livestock to an extent sufficient to interfere with the shrub layer and the ground cover. Almost all areas appear to have been selectively cut at some time. One stand has experienced selective cutting within the past 18 months.

Mixed hardwood--All stands contain some mature trees forming the canopy. Rejuvenation patterns indicate that these stands were most likely mixed hardwood in the past, having a species composition not unlike that seen today. The dominant species forming the canopy are beech, hickory, oaks (mostly white oak), and yellow-poplar. The same species are heavily represented in the secondary layer (greater than three meters but not in the canopy), with the addition of sourwood, ash, sweet gum elm, cucumber, and red maple. Also, a greater number of northern and southern red oaks are seen in this layer than the canopy.

The shrub layer (less than three meters) again contains representatives of the above mentioned species. This seems to indicate a healthy rejuvenation pattern towards a mixed hardwood climax. Also represented in the shrub layer are spice bush, euonymous, vaccinium, sumac, and dogwood.

The ground cover in these areas varies greatly due to the extent of grazing and cutting.

Cedar-hardwood, pine-hardwood, and Virginia pine--These remaining three types possess sufficient similarity, and occupy such limited area, that they are discussed together. They exist on well-drained slopes having soil allowing rapid percolation and runoff. There is little rejuvenation of softwoods with the exception of red cedar encroaching on old fields. The secondary layer composition indicates an advance on these enclaves by hardwoods. The ground cover is sparse under pines and consists primarily of legumes (trefoils).

No plants have been found on the area that have been classified as rare or endangered. The flora of the area is that fairly typical of the region (east Tennessee portion of the ridge and valley province). Use of the site for nuclear plant development should in no way have a significant impact on the vegetation, locally or regionally.

Wildlife

Wildlife species of the Phipps Bend site are largely representative of those found in the region. Investigations thus far have, however, revealed the presence of several unique faunal elements. Nesting Virginia rails have been found at Phipps Bend during the spring 1974 studies. There are six known nesting records of this species in Tennessee. Also, Willow flycatchers were found nesting in riparian vegetation along the Holston River. This bird normally is not found nesting at this latitude as it is a more northerly species.

The section of river between the Holston Ordinance Plant and John Sevier Steam Plant supports some of the highest concentrations of wood ducks in the state and is classed as the best wood duck area in east Tennessee. The Phipps Bend area also provides good habitat for shorebirds.

It is likely that fall and winter investigations will not reveal any rare or endangered species, nor do we anticipate finding additional unique habitats or species. Close coordination with construction personnel and careful land use planning will be necessary at Phipps Bend. We will be looking at these unique elements at Phipps Bend and at the completion of our field studies provide recommendations regarding them. It is our opinion that development of a nuclear plant at Phipps Bend will not have a significant impact on local or regional terrestrial ecosystems. The fact that unique species exist on the site cannot be considered categorically adverse. In fact, some unique species derive benefit from existing within an exclusion zone.

Fisheries Resource

The Holston River at the Phipps Bend site is characterized by low river flow. Preliminary sampling indicates that larval fish concentrations are low; however, the percentage of total larval fish potentially entrained would probably be higher than at other proposed sites which have higher river flow. Potential for damage to the fishery resource in the Holston River and John Sevier Reservoir is high. Flow augmentation from Patrick Henry Dam might reduce the potential for damage. Based on fishery considerations, Phipps Bend is not a "preferred" nuclear plant site.

10.0 HARTSVILLE SITE

10.1 SITE DESCRIPTION

The Hartsville site is located on the north shore of the Old Hickory Reservoir at Cumberland River mile 285, in Smith and Trousdale Counties, Tennessee, approximately five miles southeast of Hartsville, Tennessee, shown in Figure A10.0-1, which has a population of 2,243. It is 40 miles from the nearest city with a population over 25,000 -- Nashville, Tennessee, with a population of 447,877 based upon the 1970 population census. The site would consist of some 1,400 acres of rolling terrain with surface elevations ranging from 460 to 560 above mean sea level. The site would be located in an area where the predominant land uses are for agricultural purposes and forest development. An aerial photograph has been attached as Figure A10.0-2.

10.2 ACCESS FACILITIES

Highway access would require rebuilding about .5 mile of existing secondary road to connect the site with Tennessee State Highway 25, located north of the site.

Rail access would require approximately 6.4 miles of new track to connect the site with the L&N Railroad near Hartsville, Tennessee.

Barge facilities are feasible at this site.

10.3 ENGINEERING CHARACTERISTICS

10.3.1 SEISMOLOGY

The site lies within the Nashville Dome tectonic province. Design criteria for the site would be governed by a reoccurrence of a major earthquake in the Reelfoot Tectonic Structure west of the Nashville Dome. Analysis of a major earthquake reoccurring in the Reelfoot Tectonic Structure shows that the maximum intensity felt at the sites would be MM VII.

For design purposes it was assumed that the greatest acceleration affecting the site would be the result of a major earthquake occurring on the eastern boundary of the Reelfoot Tectonic Structure. Based on the envelope of attenuation curves prepared during the western area earthquake study, the maximum intensity at the site from a major quake on the Reelfoot Tectonic Structure would range from a high of MM VII to a low of MM III.

10.3.2 HYDROLOGY

The hydrologic features of the Cumberland River site would be affected by the operation of the newly constructed Cordell Hull Dam. The site has ready access to the Cumberland River for an adequate supply of water for necessary heat dissipation, auxiliary cooling and other plant needs.

10.3.2.1 GROUNDWATER

The Hartsville site is located in an outcrop area of Middle Ordovician Limestone. Water occurs in openings formed along fractures and bedding planes, some of which are solutionally enlarged. Most of the cavities are shallow; the majority of the larger cavities are clay filled.

Groundwater at the site occurs under unconfined (water table) conditions and is recharged by local precipitation. Water levels range in depth from 75 feet to less than 10 feet and average 22 feet, based on measurements made in 35 exploration holes in July 1973.

10.3.2.2 FLOOD CONDITIONS

The general site grade will be approximately elevation 545. Preliminary studies indicate the maximum possible flood level to be elevation 538.5.

10.3.3 METEOROLOGY

A detailed discussion and data for the Hartsville site are included in TVA's Hartsville Nuclear Plants Environmental Report (Environmental Report).

10.3.3.1 REGIONAL CLIMATE

The proposed Hartsville Nuclear Plant site is located in a temperate latitude in north-central Tennessee about 450 miles north of the Gulf of Mexico and in a region dominated by the Azores-Bermuda anticyclonic circulation.(1) This circulation is most pronounced in the fall and is accompanied by extended periods of fair weather, widespread atmospheric stagnation and smog.(2) In the winter, the normal circulation becomes diffuse over the southeastern part of the country as the eastward-moving migratory high- or low-pressure systems, identified with the mid-latitude westerly upper circulation, bring alternately cold and warm air masses into the Hartsville site area with resultant changes in wind, atmospheric stability, precipitation and other meteorological elements. In summer, the migratory systems are less frequent and less intense since the site area is under the influence of the western extension of the Azores-Bermuda anticyclonic circulation with frequent incursions of warm moist air from the Atlantic Ocean and the Gulf of Mexico.

10.3.3.2 LOCAL METEOROLOGY

Because of the shallow valley and surrounding irregular terrain, marked throughout by low rolling hills, there is an absence of pronounced river-valley or valley-ridge features in the proximity of the plant site area. Some minor discontinuities can be expected in the prevailing low-level regional wind because of the higher terrain to the north-northeast through east which slopes downward into the shallow and elongated east-west valley where the plant site is located. The principal effect of this topographic configuration on the dispersion of gaseous effluent releases from the Hartsville plants would be one of limited confinement within the shallow valley by the weak and stable east and east-northeast downvalley drainage winds. Ground-level concentrations therefore would likely be the greatest in the west and west-southwest downvalley sections. No local wind effects are expected from differential surface heating between land and water because of the narrow Cumberland River as it flows westward along the south boundary of the plant site.

10.4 POPULATION

The site is located about six miles northwest of Hartsville, Tennessee, which has a population of 2,243. Carthage, Tennessee, population 2,500 is about 10 miles southeast of the site.

10.5 ENVIRONMENTAL CHARACTERISTICS

10.5.1 LAND USE

No major development is located near this site. The land is presently used for agricultural and forestry purposes. There are no public recreation areas in the immediate vicinity (1 to 2 miles) of this site.

10.5.2 ARCHAEOLOGICAL SIGNIFICANCE

The Hartsville site was surveyed by Dr. Major C. R. McCollough, TVA's archaeological consultant. The investigation consisted principally of the identification of archaeological sites and historic features which could be affected by steam plant construction and operation at each site. The investigation revealed that the Hartsville site is a relatively rich archaeological location.

10.5.3 HISTORICAL SIGNIFICANCE

Based on a review of the "National Register of Historic Places", state preservation plans and detailed onsite consultant reports,[3] the Hartsville site was judged to have some potentially significant historical developments. Development of Hartsville would require coordination with appropriate Federal, state and local officials to ensure the proper consideration of any structures that might be affected by plant construction which are determined to be significant under the National Historic Preservation Act of 1966.

The procedures outlined by the National Park Service, Department of the Interior,[4] provide that historical and environmental considerations may be combined in a single document, the environmental statement, which will be distributed widely for comment by appropriate Federal, state and local agencies, and interested persons. After consideration of all comments received, a final decision can be made regarding the historical, architectural, archaeological and cultural significance of properties within the area affected by the project.

10.6 ECOLOGY

10.6.1 TERRESTRIAL

The Hartsville site has been used intensively by man for agricultural purposes for many years. Heavily fenced, it consists primarily of pasture, cropland and understocked woodland. Human activity, particularly cultivation, has continually disrupted plant and animal communities.

The site is located in the Nashville or Central Basin physiographic province and is within the western mesophytic forest region.

The vegetation of the Hartsville site has been tentatively categorized into seven arbitrary zones: (a) limestone knolls with mostly closed woods but occasional open spaces; (b) open woods and deciduous tree rows primarily occurring along property lines; (c) pastures; (d) old fields; (e) cultivated areas; (f) fence rows; and (g) riparian woodlands. Principal plant communities are shown in Figure A10.0-3.

The site has no unusual terrestrial habitats, primarily because of the relatively intense argicultural activities in the area. There are no river bluffs or caves on the site. The wooded knolls afford the largest amount of terrestrial bird and small mammal habitat. The riparian woodland areas along Dixon Creek, the Cumberland River and Dixon Island constitute another important habitat type at the site.

In summary, the wooded areas, although quite small relative to the size of the entire site, are expected to support a myriad of songbirds, herpetiles and small mammals. Fence rows also should support a variety of wildlife species.

No unique, rare, or endangered animal species are known to occur on the site.(5) A rare and endangered plant, marbleseed (Oposmoduim molle), was found in open areas on the limestone knolls. This species will not be affected by plant construction since it is located well outside the areas of plant construction.

10.6.2 AQUATIC

Site assessment studies of fish populations were initiated in the fall of 1972. In May 1973, two limnological site surveys were made by TVA to assess the general biological conditions of the area. One survey was to collect general limnological data at three stations on the Cumberland River in the vicinity of the Hartsville site and the other was a preliminary benthic faunal survey of streams located near the site.

Detailed discussions of the nature of both the terrestrial and aquatic communities in the site vicinity can be found in the environmental report submitted to the AEC by TVA on July 1, 1974.

10.6.2.1 FISH

The piscine community near the Hartsville site is a mixture of stream and lake forms as is typical of reservoir headwaters. Four cove samples, shown in Table A10.0-1, yielded an estimated standing crop of 149.5 to 826.9 pounds per acre. In the four cove samples, gizzard shad were numerically dominant as they were in gill net samples, Table A10.0-2, and electrofishing samples, Table A10.0-3. Bluegill, carp and drum were also abundant in cove samples. A total of 35 fish species were collected in the four cove samples.

10.6.2.2 OTHER AQUATIC LIFE

Studies revealed a moderately varied phytoplankton and zooplankton community. Diatoms (Chrysophyta) and green algae (Chlorophyta) dominated the phytoplankton. Keratella crassa (Rotifera) was the most abundant of 42 zooplankton taxa noted in preliminary site studies.

The benthic fauna community diversity was quite low at all stations. Detailed data can be found in the environmental report submitted to the AEC by TVA on July 1, 1974.

10.7 CONCLUSION

A thorough assessment of the Hartsville site is provided in the TVA Hartsville Environmental Report which was submitted to the AEC on July 1, 1974. The site is currently proposed as the location of a commercial-sized, four unit LWR generating facility.

TABLE A10.0-1

SPECIES COMPOSITION BY NUMBERS AND WEIGHT OF FISHES TAKEN BY COVE-ROTENONE SAMPLING IN THE VICINITY OF DIXON CREEK; SEPTEMBER 1972 AND SEPTEMBER 1973

Species	Percent by Number				Percent by Weights			
	1972		1973		1972		1973	
	A*	B**	A	B	A	B	A	B
Paddlefish	t	0.2	--	--	0.5	1.5	--	--
Longnose gar	t	0.4	t	0.1	t	0.6	0.1	0.2
Skipjack herring	0.4	1.0	t	--	t	0.1	0.1	--
Gizzard shad	87.3	51.9	89.2	91.2	45.3	26.3	71.7	65.7
Threadfin shad	0.3	2.5	1.6	--	t	0.1	0.2	--
Carp	4.4	4.6	1.4	0.2	37.9	27.6	15.7	1.4
Golden shiner	--	0.2	--	--	--	t	--	--
Emerald shiner	--	1.5	--	--	--	t	--	--
River carpsucker	0.1	0.6	0.1	--	0.7	2.9	0.7	--
Quillback	--	--	--	t	--	--	--	0.1
Smallmouth buffalo	0.4	1.3	0.3	0.3	3.1	11.4	3.6	3.5
Bigmouth buffalo	0.6	0.4	t	0.2	6.7	6.0	0.6	3.1
Black buffalo	--	--	--	t	--	--	--	0.6
Spotted sucker	t	0.2	0.2	t	0.2	1.1	1.0	0.1
Black redhorse	--	--	--	--	--	--	--	--
Golden redhorse	0.2	--	0.3	t	0.4	--	1.5	0.1
White sucker	--	0.2	--	--	--	1.1	--	--
Black bullhead	t	--	--	--	t	--	--	--
Yellow bullhead	--	--	t	0.4	--	--	0.1	1.2
Channel catfish	t	0.4	0.1	t	t	2.6	0.5	0.1
Mosquitofish	t	--	--	--	t	--	--	--
Brook silverside	--	--	t	--	--	--	t	--
White bass	t	--	t	--	t	--	t	--
Green sunfish	0.1	--	t	t	t	--	t	t
Warmouth	--	1.3	0.1	0.1	--	0.2	t	t
Bluegill	2.4	20.5	4.5	2.8	0.6	5.5	1.4	0.8
Longear sunfish	0.1	0.4	--	t	t	0.1	--	t
Redear sunfish	--	0.2	--	--	--	0.1	--	--
Smallmouth bass	--	0.2	--	t	--	0.1	0.1	0.1
Spotted bass	t	--	--	--	0.2	--	--	--
Largemouth bass	0.1	--	0.3	0.3	0.6	--	0.6	0.1
White crappie	0.4	2.5	0.4	1.9	0.2	2.8	0.2	0.5
Black crappie	0.3	0.6	0.3	0.1	t	0.4	0.2	t
Sauger	0.2	0.2	0.2	0.1	0.4	0.1	0.2	0.1
Freshwater drum	2.3	8.8	0.8	0.4	3.0	9.4	1.5	0.8
Total Standing Crop (Pounds/acre)	826.9	231.7	149.5	394.4				

*Dixon Creek cove
**Cove 2.5 km (1.6 mi) below the mouth of Dixon Creek
t = less than 0.05 percent

Table A10.0-2

RESULTS OF GILL NET SAMPLING ON
OLD HICKORY RESERVOIR NEAR DIXON SPRINGS

Date Net-Nights	9/72 12	9/73 12	11/73 34	1/74* 40	4/74 30
Paddlefish	--	--	--	--	1
Longnose gar	1	7	4	--	--
Skipjack herring	--	--	1	15	14
Gizzard shad	--	--	--	51	55
Threadfin shad	--	--	--	--	1
Mooneye	--	--	1	1	--
Carp	2	4	15	--	--
River carpsucker	3	3	11	1	1
Quillback	--	--	--	--	1
Smallmouth buffalo	--	2	23	2	2
Bigmouth buffalo	--	--	1	--	--
Spotted sucker	--	--	--	1	7
Black redhorse	--	--	--	5	4
Golden redhorse	--	7	1	4	12
Shorthead redhorse	--	2	--	--	--
Channel catfish	--	1	7	14	--
Yellow bullhead	1	--	--	--	--
Black bullhead	--	--	--	--	1
White bass	--	--	--	--	2
Striped bass	--	--	1	--	--
Bluegill	--	3	3	--	--
Redear sunfish	--	1	--	--	--
Largemouth bass	--	--	--	--	1
Sauger	--	--	1	--	1
Walleye	--	--	1	9	--
Freshwater drum	2	2	1	289	16

*All nets on these nights were in the backwater areas of Dixon Creek.

TABLE A10.0-3

RESULTS OF ELECTROFISHING ON
OLD HICKORY RESERVOIR NEAR DIXON SPRING

Species	9/72	9/73	4/74
Number of hours of electroshocking	10	0.75	1.5
Longnose gar	2	--	--
Gizzard shad	598	9	149
Threadfin shad	70	--	19
Mooneye	15	--	3
Emerald shiner	--	--	7
Carpsucker	1	--	--
Carp	78	8	1
Smallmouth buffalo	10	2	6
Bigmouth buffalo	1	--	--
Black redhorse	--	1	--
Golden redhorse	--	10	--
Black bullhead	1	--	--
Bluegill	130	7	--
Longear sunfish	30	--	--
Spotted bass	1	--	--
Largemouth bass	3	2	--
Logperch	--	1	--
Walleye	--	3	--
Freshwater drum	3	--	1

Figure 10.0-1 HARTSVILLE SITE, CUMBERLAND RIVER MILE 285R

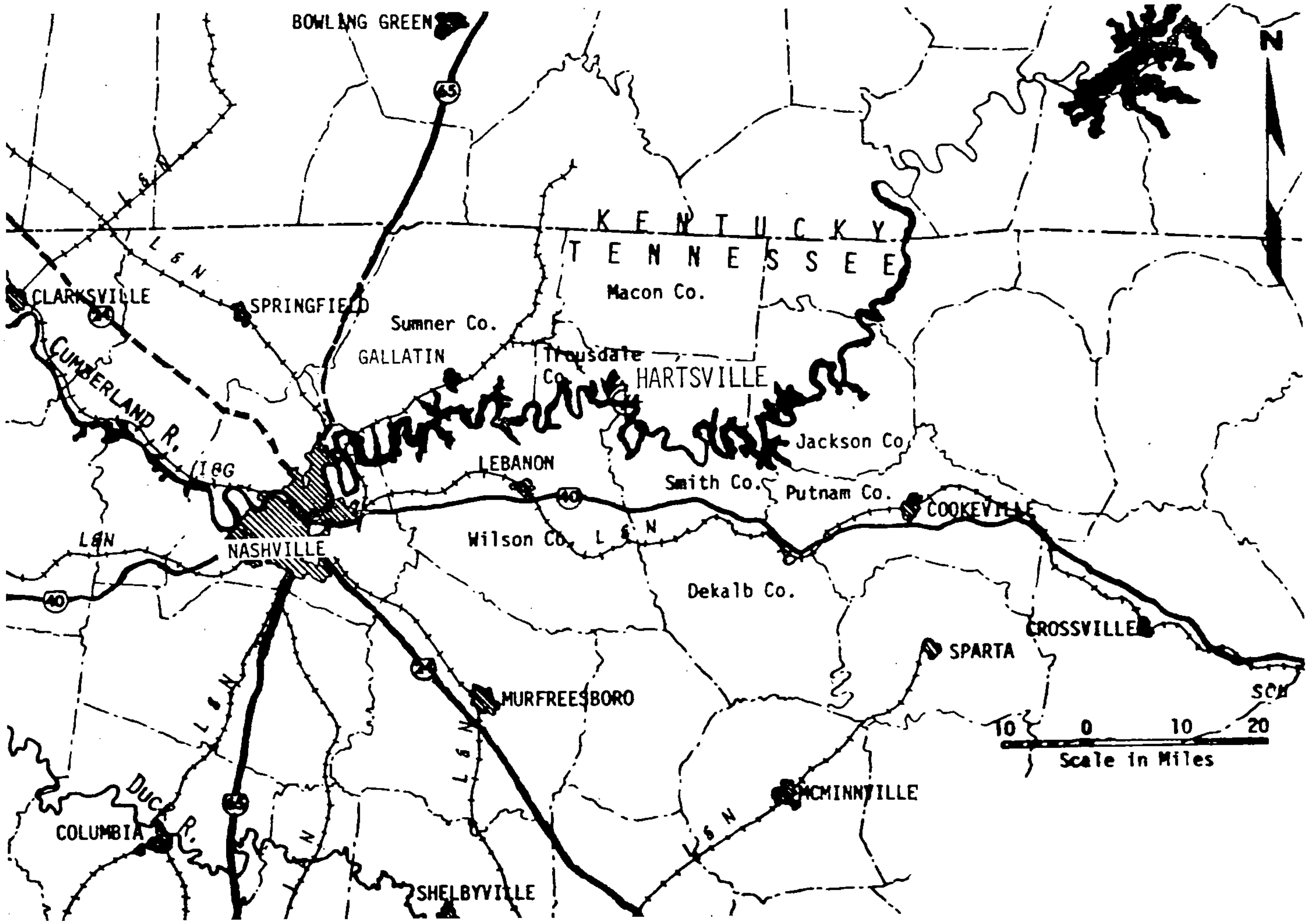

Figure 10.0-2 LOCALITY MAP, HARTSVILLE SITE

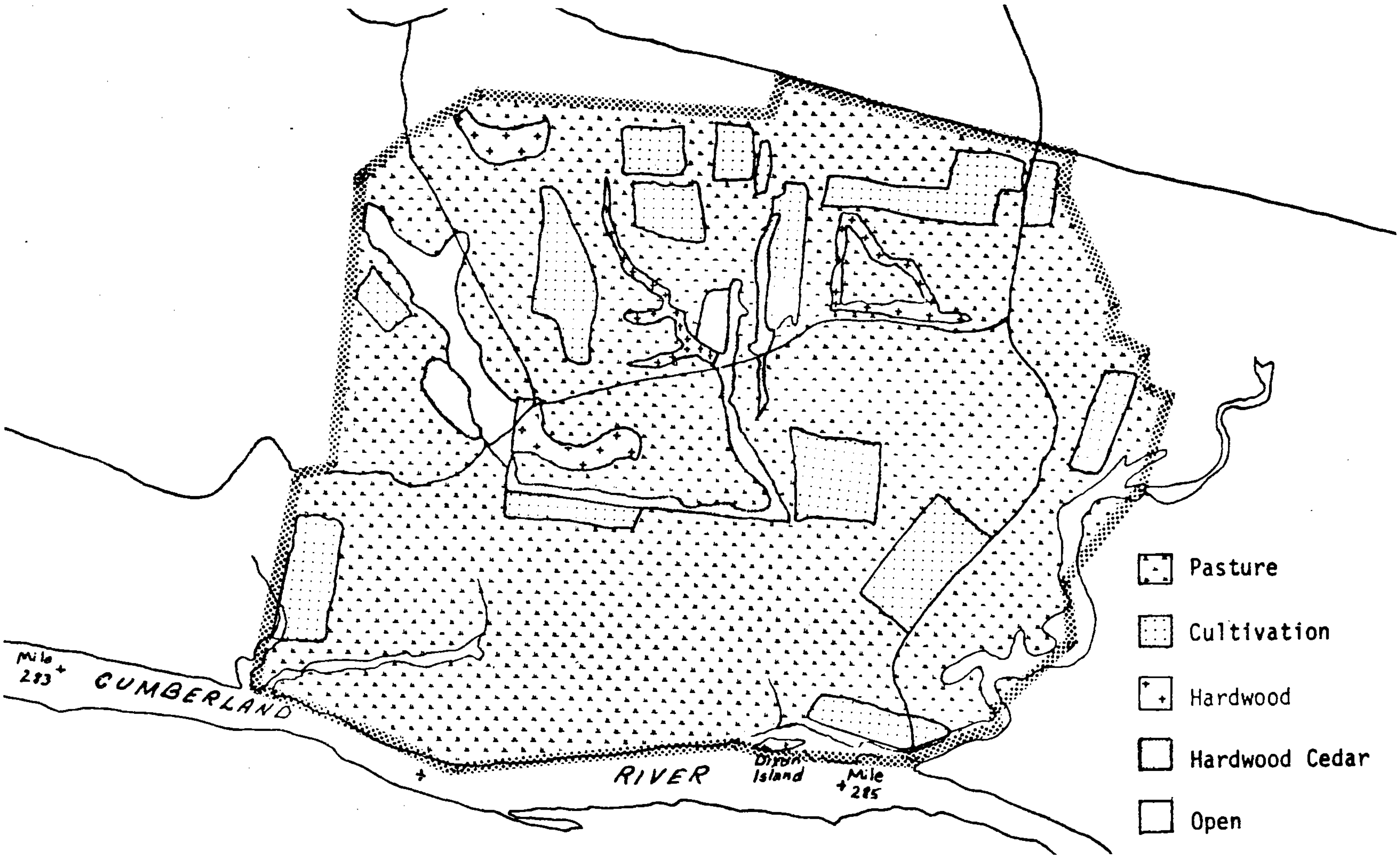

Figure 10.0-3 PRINCIPAL PLANT COMMUNITIES

10.0 REFERENCES

1. U. S. Atomic Energy Commission, A Meteorological Survey of the Oak Ridge Area, ORO-99, Weather Bureau, Oak Ridge, Tennessee, November 1953, p 377.

2. U. S. Atomic Energy Commission, A Meteorological Survey of the Oak Ridge Area, ORO-99, Weather Bureau, Oak Ridge, Tennessee, November 1953, p 192.

3. McCollough, Major C. R., Archaeological Surveys of Antioch and Johnstown Steam Plant Sites on Old Hickory Reservoir near Gallatin, Tennessee, University of Tennessee, September 15, 1972.

4. Federal Register, Washington, D. C., Vol 39, 1974, pp 6402-77.

5. U. S. Department of Interior, Threatened Wildlife of the U.S., Office of Endangered Species and International Activities, Resource Publication 114, March 1973, p 289.

11.0 RIEVES BEND SITE

11.1 SITE DESCRIPTION

The Rieves Bend site is located on the south shore of the proposed Columbia Reservoir at Duck River mile 146, about three miles southeast of Columbia, Tennessee. The site consists of approximately 1,500 acres. Ground elevations vary from 630 feet at the Duck River shoreline to 740 feet. Figure A11.0-1 is an aerial view of the site.

There is no intensive development in the immediate vicinity of the site nor is any expected in the future.

11.2 ACCESS FACILITIES

Highway access for the site would require about 2.5 miles of new road to connect the site with Tennessee State Highway 50 which connects with I-65.

Rail access would require 2.5 miles of new track and the crossing of two embayments of the Columbia Reservoir to connect the site with the L&N Railroad.

Barge facilities are not feasible at the site due to the non-navigability of the Duck River.

11.3 ENGINEERING CHARACTERISTICS

11.3.1 SEISMOLOGY

The Rieves Bend site lies within the Nashville Dome Tectonic Province. This area is one of minimum earthquake hazard, not only because it is structurally stable itself but also because of its distance from known areas of past earthquake activity such as the locus of the New Madrid quakes--the Reelfoot Tectonic Structure. It has been the site of epicenters of a few small earthquakes which were not related to known faults and the seismic origin of some of these shocks is questionable. Similar small quakes are to be expected in the future, but the effects of such quakes would be less than the attenuated effects from major earthquakes occurring on the Reelfoot Tectonic Structure to the west.

There are no active faults in the vicinity of the site and there is no physical evidence of any seismic activity. The nearest known epicenter of damaging intensity (MM VII) is over 100 miles from the site. The maximum intensity estimated to have been felt at the site during recorded history of the area is probably MM VII-VIII associated with the December 16, 1811, New Madrid earthquake.

11.3.2 HYDROLOGY

The Rieves Bend site is located on the Duck River. The site is at river mile 146 and about 1,000 square miles of the Duck River drainage area are above the site.

11.3.2.1 GROUNDWATER

The Rieves Bend site is located in an outcrop area of Middle Ordovician Limestone. Water occurs in openings formed along fractures and bedding planes, some of which are solutionally enlarged, and a few exceed three feet in thickness. Most of the larger cavities are within 20 feet of the top of bedrock.

Groundwater at the site occurs under unconfined (water table) conditions and is recharged by local precipitation. Water levels range from a known maximum depth of 84 feet to less than 10 feet, based on measurements made in June 1972 in 30 exploration holes. Mean depth to water table is 33 feet. Discharge is to Duck River and its tributary, Fountain Creek.

11.3.2.2 STREAM FLOWS

The mean daily streamflow, based on a 1953-69 period of record, is 1,710 ft^3/s. The minimum daily flow is only 27 ft^3/s. As stated previously, the Duck River is now unregulated, but two major reservoirs (Columbia Dam and Normandy Dam) are planned. The Normandy Dam site is at river mile 248.6, about eight miles north of Tullahoma, Tennessee. The Columbia Dam site is at river mile 136.9, about nine miles downstream from the proposed Rieves Bend site, which would be on the reservoir when the dam is built. Future flows at the Rieves Bend site will depend on the operation of both the Columbia and Normandy Dams. Reversals of flow could occur, the duration of which is not known.

11.3.2.3 WATER SUPPLY

The Rieves Bend site is located at Duck River mile 146. The proposed Normandy Dam is to be located upstream from Rieves Bend, but the proposed Columbia Dam is about nine miles downstream from Rieves Bend. Thus, Rieves Bend would be located on the Columbia Dam Reservoir. The main water use for the Columbia and Normandy Dam areas will be to reduce local flooding; provide a new range of recreation, fish and wildlife opportunities; and provide a more dependable, improved municipal and industrial water supply.

There are now 7 public and 12 industrial water supplies within a 20-mile radius of the proposed plant site. Five of the surface supplies, including the municipal supply for Columbia which serves 26,200 people, are downstream of the proposed plant site.

The Duck River area, particularly in the vicinity of Columbia, Tennessee, has in the past experienced severe water supply shortages during periods of low streamflow. A portion of the justification for the Duck River project is directly associated with the water supply and water quality control needs of the basin. Contracts have already been negotiated with local governments for the reimbursement of the portion of the Federal investment in the project allocated for water supply purposes. The evaporative losses resulting from the development of this site could result in water use conflicts with the proposed Duck River project. The low streamflows and high natural stream temperatures at this site could severely restrict the amount of waste heat that could be discharged without violating the Tennessee thermal criteria, and the system for recycling cooling tower blowdown would probably be required.

11.3.2.4 WATER QUALITY

The general water quality above the site is good although high concentrations of total and fecal coliform bacteria have been observed several times. The maximum observed water temperature during this period was 83 degrees F at DRM 156.5. Daily water temperatures observed at the USGS stream gage at Columbia (about 13 miles downstream from the site) for the years 1946-49 indicated a maximum daily water temperature of 88 degrees F. In August 1947 the average monthly temperature was 83 degrees F while in July 1948 the average monthly temperature was 84 degrees F. If the Columbia Dam is built, water temperatures at the surface and five-foot depth will probably be higher than those observed at Columbia.

11.3.3 METEOROLOGY

Because of the absence of any pronounced river-valley or valley-ridge terrain features, no significant discontinuities of the prevailing regional or local wind patterns are expected at the site. On rare occasions weak southerly and stable low-level winds might result in poor atmospheric dispersion conditions resulting from entrainment by the low-level terrain which flanks the peninsula to the west, north and east.

Wind measurements at 40 feet aboveground at the Monsanto, Tennessee, Cooperative Observer Station for the period 1965-70 are used to describe the regional wind patterns in the Rieves Bend area. These data show that the predominate wind directions are from the south-southwest (181° to 225°) and west-northwest (271° to 315°) sectors. Average wind speeds for the sector directions are 4.6 and 4.3 mph, respectively.

Wind measurements at 75 feet aboveground and temperature measurements at 4 feet and 300 feet aboveground for 1971 at the Browns Ferry Nuclear Plant meteorological facility are used to identify the expected low-level atmospheric dispersion conditions at the Rieves Bend site.

Although the general stability conditions identified from the Browns Ferry data should be reasonably representative of the Rieves Bend site, the associated wind patterns show certain discontinuities in the comparable direction frequencies.

However, the expected prevailing south-southwesterly wind in the site area would occur about 24 percent of the time with an average wind speed of 4.6 mph. The secondary maximum west-northwest wind would occur about 17 percent of the time with an average wind speed of 4.3 mph.

The atmospheric stability conditions at the Rieves Bend site are estimated from the one year (1971) of vertical temperature difference data between the 4- and 300-foot tower levels at the Browns Ferry meteorological facility.

The Pasquill stability classes E, F and G occur about 42 percent of the time. The most critical class, G, occurs about 11 percent of the time. The least stable classes, A, B and C occur about 34 percent of the time, while the neutral class, D, occurs about 24 percent of the time.

The most critical atmospheric dispersion condition, class G, 1 to 3 mph, occurs only 3.68 percent of the time with an additional 0.03 percent calm. Classes E and F have respective frequencies of 1 to 3 mph and calm conditions of 1.94 and 0.01 percent for class E and 2.64 and 0.0 percent for class F.

11.4 POPULATION

11.4.1 POPULATION WITHIN 10 MILES

Columbia, Tennessee, with a 1970 population of 21,471, dominates the population distribution pattern within 10 miles of the site with the sectors containing or related to the city (5 to 10 miles west, west-northwest, northwest and north-northwest) accounting for 71 percent of the total population of the 10-mile area. The remaining area is very sparsely settled. Present growth trends suggest an intensification of this pattern with all of the 1970-2000 population growth concentrated in the same sectors. This would result in 84 percent of the year-2000 population being located in the above-mentioned sectors.

Figures A11.0-2 and A11.0-3 contain the present and the projected populations for the year 2000 at various distances and directions from the site out to 10 miles, as represented by the site locality map shown in Figure A11.0-4.

11.4.2 POPULATION WITHIN 50 MILES

Within 50 miles of the Rieves Bend site are 22 counties with at least five percent of their population inside the radius. South-central Tennessee contains 20 of these counties while the remaining two are in north-central Alabama. The 22 counties contained 994,008 people in 1970, which was an increase of 12 percent over 1960 as compared with an increase of 13 percent for the nation.

Nashville-Davidson County is the only major urban concentration (a population of 50,000 or more) within 50 miles of the site. The urbanized area extends from about 34 miles to over 50 miles from the site to the north-northeast and contained a population of 448,444 in 1970. Of the total population, an estimated 411,500 were located within the 50-mile radius.

Four smaller population centers (population between 10,000 and 50,000) are located in the region. They are:

City	Distance (miles)	Direction	1970 Population
Shelbyville, Tennessee	38	ESE	12,262
Tullahoma, Tennessee	45	ESE	15,311
Murfreesboro, Tennessee	37	ENE	26,360
Columbia, Tennessee	6	NW	21,471

Numerous smaller communities and crossroads settlements are dispersed throughout the region surrounded by low-density rural development.

Over 50 percent of the future population growth is expected to occur in and around Nashville-Davidson County. This is in the 30- to 50-mile range to the north and north-northeast. However, Murfreesboro is expected to become a major urban concentration by the year 2000. The 30- to 40-mile range to the northeast and east-northeast (containing Murfreesboro and its growth area) accounts for an additional 10 percent of the region's growth.

11.5 ENVIRONMENTAL CHARACTERISTICS

11.5.1 LAND REQUIREMENTS

There are two principal factors which result in land requirement variations at Rieves Bend. If the Columbia Dam were constructed as planned, only 250 acres of land would be purchased for the Rieves Bend site. This amount is based on utilizing about 1,280 acres of the land purchases associated with the Columbia Reservoir impoundment. If the Columbia Reservoir is not built, the above mentioned 1,280 acres would have to be purchased. In addition, the construction of a retention dam on Fountain Creek (if the Columbia Reservoir is not built) would require approximately 2,600 acres.

11.5.2 LAND USE

With the exception of the city of Columbia and its environs, the predominant land uses within 10 miles of the Rieves Bend site are a mixture of cultivated land, active and vacant pasture land, and low-grade forest land. Rural dwellings are interspersed throughout this area with very little concentration.

Projected land use, based on completion of the Columbia Reservoir, includes a public park to the west, residential development to the north and a commercial recreation development to the northwest. Each of the developments are across the reservoir from the site. Development of the Rieves Bend site for a nuclear plant would not preclude these developments directly but could reduce the natural attractiveness of the reservoir to the extent that the projected development would be less likely to occur. This land use consideration is in addition to any effect operation of the proposed plant might have on recreation use of the reservoir due to summer reservoir fluctuations.

11.5.3 ARCHAEOLOGICAL SIGNIFICANCE

An archaeological survey was conducted at the Rieves Bend site in 1972 by David R. Evans and David J. Ives, Consulting Archaeologists. A copy of this report is attached as Appendix I to Section 11.0.

11.5.4 HISTORICAL SIGNIFICANCE

Preliminary review of the historical significance in the area around the Rieves Bend site was conducted by reviewing the January 1, 1971, edition of the Tennessee Plan for Historical Preservation. Within the town of Columbia, or immediately on its fringe, there are eleven properties now being considered for further historical preservation work and five properties which are already in the "National Register of Historic Places." However, in examining the general description of these property locations, none of them appear in the immediate area of this site. The majority of these properties are homes of Civil War and pre-Civil War construction.

11.5.5 RECREATION

Studies at the Rieves Bend site indicate that only two areas have a peak-hour attendance greater than 100. One area fell within the 4- to 5-mile zone and the other in the 7- to 8-mile zone with attendance levels of 150 and 145, respectively.

11.6 ECOLOGY

11.6.1 VEGETATION

A vegetational survey was conducted in 1972 by Dr. G. E. Hunter and Donald Ott. A copy of their report is attached as Appendix II to Section 11.0.

11.6.2 FISHERIES AND WILDLIFE

Studies of fishery resources at the Rieves Bend site indicate a small standing crop, but a wide variety of species. No rare or endangered species were noted or suspected.

Certain species of fish are indicators of clean water in smallmouth bass and rock bass streams. Included are: smallmouth bass, spotted bass, rock bass, sonte rollers, redhorse species and practically all the stream minnows.

No significant environmental losses would be expected to occur as far as wildlife is concerned. The expectation of finding rare or endangered species of breeding birds was judged to be unlikely. The presence of the endangered bat, Myotis sodalis, is considered to be a remote possibility in this area.

From this information it appears that no significant environmental impact on birds and mammals is considered likely.

11.7 CONCLUSION

This site was judged to be of less desirability due to the potential for a significant water use conflict with the use and development of the Duck River. In addition, access to the site would be limited to overland transportation routes since barge access is not possible at this site.

Figure 11.0-1 RIEVES BEND SITE, DUCK RIVER MILE 146L

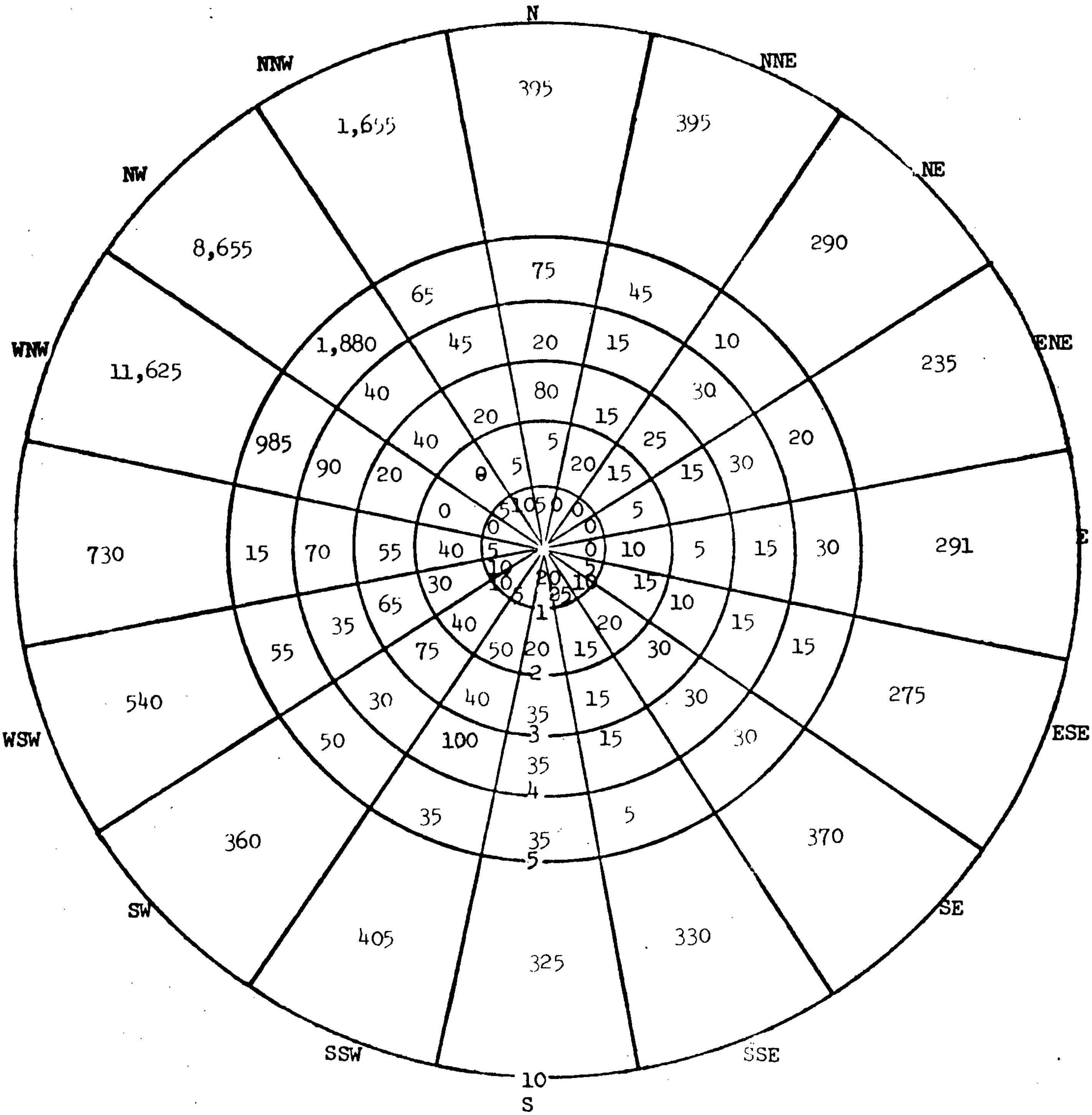

Figure 11.0-2 POPULATION DISTRIBUTION, 1974, RIEVES BEND SITE

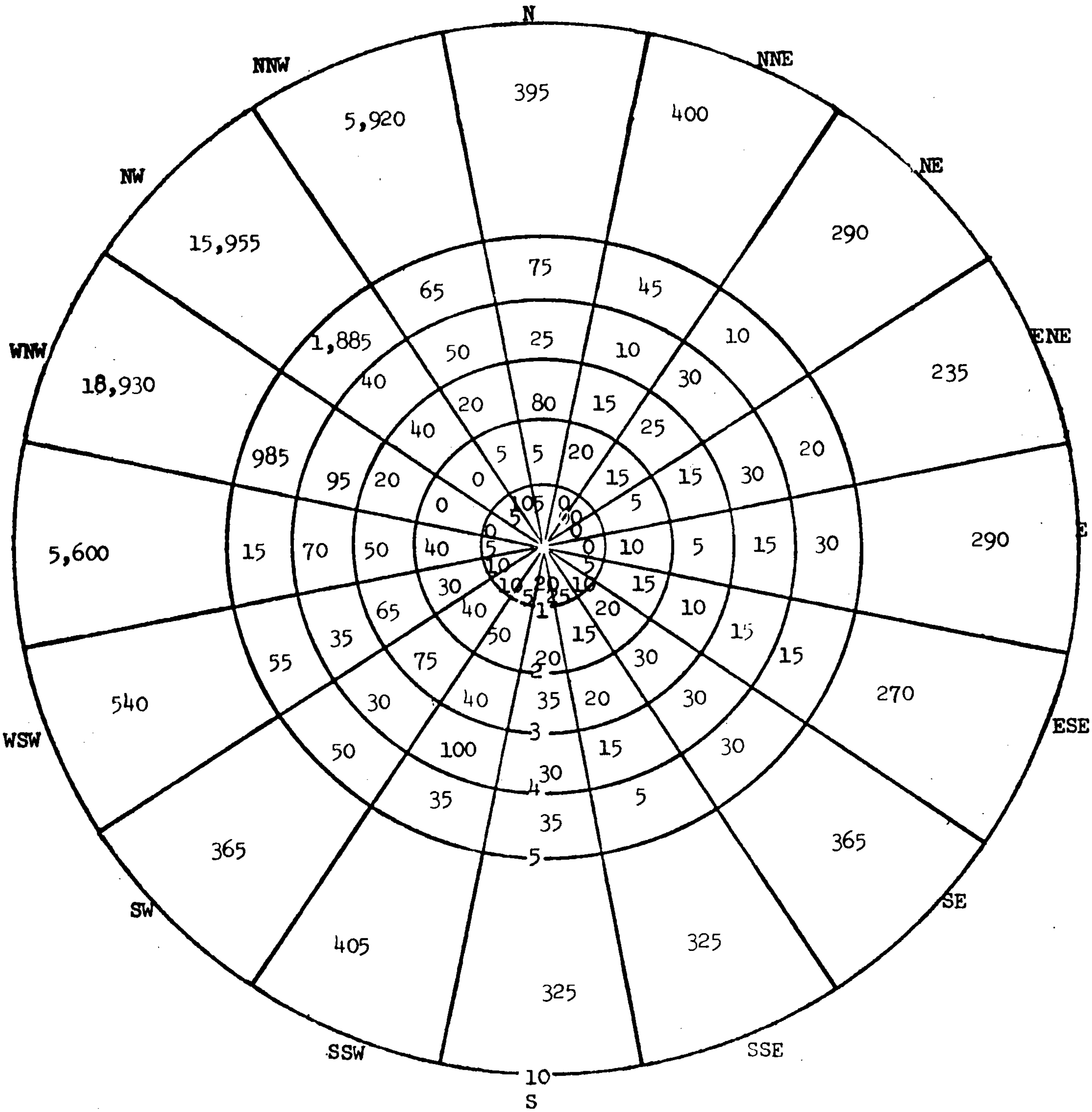

Figure 11.0-3 POPULATION DISTRIBUTION, 2000, RIEVES BEND SITE

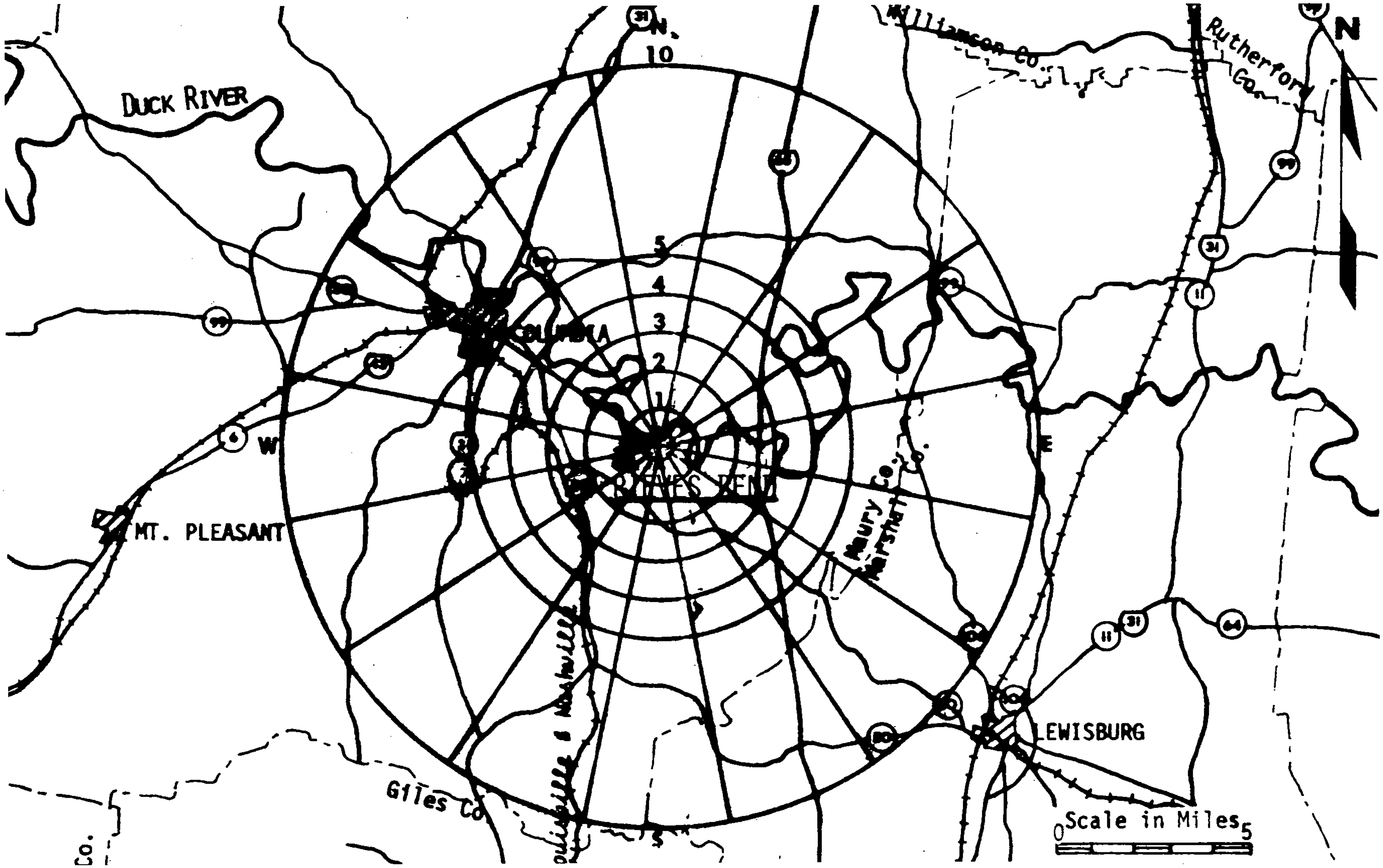

Figure 11.0-4 POPULATION LOCALITY MAP, 10-MILE RADIUS, RIEVES BEND SITE

APPENDIX I TO SECTION 11.0

OF

APPENDIX A

ARCHAEOLOGICAL SURVEY REPORT

RIEVES BEND

ARCHAEOLOGICAL IMPACT--RIEVES BEND SITE
MAURY COUNTY, TENNESSEE

DAVID R. EVANS AND DAVID J. IVES
CONSULTING ARCHAEOLOGISTS

SEPTEMBER 15, 1972

RIEVES BEND SITE STUDY (ARCHAEOLOGICAL IMPACT)

Initial archaeological survey prior to the preparation of evaluations of the archaeological resources of the Rieves Bend site began on September 8, 1972. Information available at that time consisted of a circle on the Glendale 7.5 minute topographic map and a map showing test drilling patterns for site examination. No information regarding land modification if this site is selected for a power plant was available. Core drilling operations are currently underway in the area and those areas were examined for archaeological remains. The site is located between mile 145-146 on the left bank of the Duck River. The project area is in Maury County, Tennessee, on dissected high land adjacent to the river. Portions of the "exclusion area" encircled on the topographic map are also included in the proposed Columbia Reservoir project area.

INVENTORY OF ARCHAEOLOGICAL REMAINS

At the beginning of the study, no known archaeological remains had been located. Previous archaeological survey in the Columbia Reservoir area located eight sites near the confluence of Fountain Creek, immediately adjacent to the west of the exclusion area.

At the time of the survey, only two small tobacco fields and one corn field were in cultivation. One additional field, a pasture, was sufficiently clear for surface survey. Extremely heavy vegetation from abundant water this year precludes effective surface survey at this time of year.

<u>40 MU 17</u> A site located in a tobacco field of Mr. Moser and on high land. This site is collected by Mr. Moser's grandson for Indian artifacts. Little debris was found on the surface and, unfortunately, no specimens reported from the site were available for examination.

Sufficient evidence is present to demonstrate the presence of a prehistoric site, although temporal span and site limitation is impossible to accurately determine. This site should be examined further.

40 MU 18 A small campsite located in an overgrown soybean field which had just been cut and baled for hay at the time of survey. The site is located on the highland on the center of the western lobe of the field. It is located on the L. Dickson property. Surrounding the field is dense vegetation of uncleared forest. Temporal and cultural affiliation is unknown at this time.

40 MU 19 A small campsite similar to 40 MU 18 and located in the same field. This site is located at the northern end of the soybean field.

Other sites suggested for further examination although not numbered in the Archaeological Survey of Tennessee because of lack of evidence at this time include one mound located 45 feet north of TVA drill coordinate M, 74+00 on the line between M and N. This small mound could be aboriginal although no artifacts or other cultural debris were found. Testing of this area should be done. It is on Mr. L. Dickson's property.

A second site is located on Mr. Moser's property and is directly north of 40 MU 17. Reported artifacts from the site and it's similarity to 40 MU 17 suggest that it is probably an aboriginal site although insufficient evidence was found upon surface examination in the initial survey to assign a site number to it. It should be examined further.

Finally, a site north of Mrs. Uzzel's house was located where a series of at least 12 depressions about 8 feet by 4 feet and up to 2 feet deep were located. A mound of earth and rock is adjacent to each depression. They were shown to us as "Indian Graves" although their exact identification without testing is unsure. The possibility of military entrenchments or foxholes cannot be ruled out.

At a time when the actual modification of the exclusion area is known, all located sites should be tested and an intensive survey made preferably at a time of year when ground cover is surmountable, or through statistically valid prospecting programs. There are definitely archaeological resources present in the exclusion area, although in the areas of intensive drilling, location of archaeological remains seems unlikely. Severe modification of the land where drilling tests have been made would certainly have damaged any sites present even prior to project approval.

MAP SHOWING LOCATED REMAINS (See Map)

SIGNIFICANCE OF SITES EFFECTED

Evaluation of the significance of effected sites is not possible without more information about the location and nature of the remains. Ground cover and lack of farming activities prevented the initial survey from doing little more than locate and demonstrate the presence of prehistoric remains in the area. Although slightly outside the exclusion area, an early cemetery, the Holland Cemetery where Major James Holland was buried in 1825 along with many family members is located. This cemetery is not shown on the topographic map although it is located on the accompanying map. Atkinson cemetery which is noted on the topographic map immediately behind the Uzzell home contains no grave stones.

HOW THE RIEVES BEND PROJECT WILL EFFECT THE ARCHAEOLOGICAL RESOURCES

Since the exact nature and construction plans for the power plant project were not available to the archaeologists, evaluation cannot be made in specific terms. If a site is present where the terrain will be modified, either through removal of earth or construction activities, the site will be destroyed. Although in the vicinity of the two concentrated drilling tests, little appears to be present in the form of archaeological remains, earth removed from other parts of the exclusion area could easily destroy archaeological sites. Thus, this evaluation must be made at a later time.

RECOMMENDED PROGRAM

Should the Rieves Bend Project be approved for construction, an intensive survey should be made and testing conducted on located sites. Evaluation of the impact on the resources can only be made after the project plans are available.

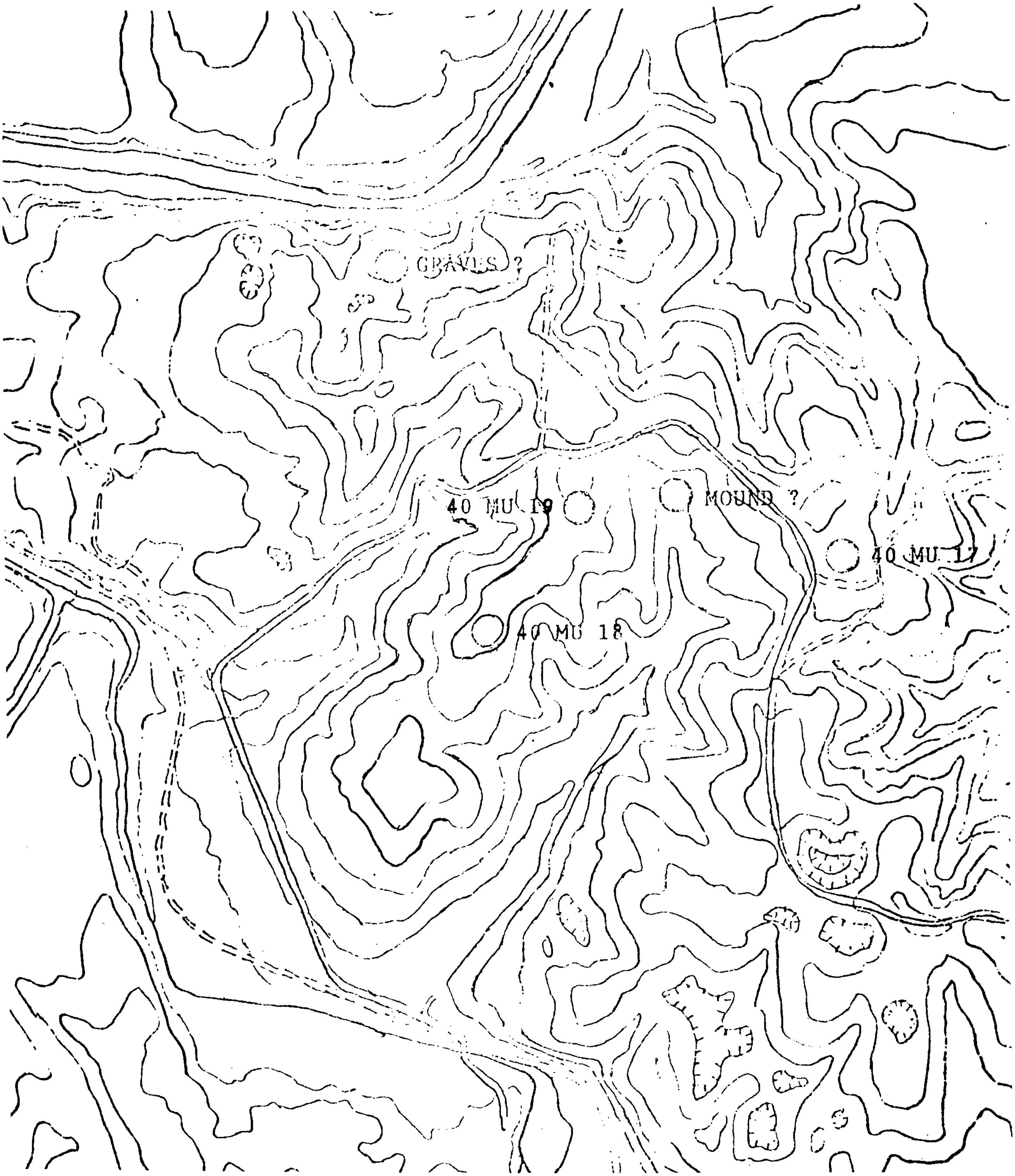

Figure 1 RIEVES BEND SITE ARCHAEOLOGICAL REMAINS

APPENDIX II TO SECTION 11.0

OF

<u>APPENDIX A</u>

VEGETATIONAL SURVEY REPORT

RIEVES BEND

VEGETATIONAL SURVEY

Rieves Bend Site

Duck River

Dr. Gordon E. Hunter
Tennessee Technological University

Donald Ott
University of Tennessee

A Survey of the Vascular Plants of the Rieves Bend Area of the Duck River, Maury County, Tennessee.

At the request of the Norris office of the Tennessee Valley Authority, a survey was made of the terrestrial vascular flora of the Rieves Bend Area of the Duck River in Maury County, Tennessee. A list of the plants growing in the region was requested, and it was requested that, if possible, a subjective judgement of the frequency of species be made. No precise quantitative information was requested. Maps of the existing vegetation were requested. Designation of vegetational types on these maps was to be generalized. Special note was to be made of any rare or endangered species.

The survey was conducted from August 19 to August 30, 1972. Two men spent five days each in the field during this period. Initially, each investigator surveyed by car the area encompassed by a one-mile radius from a central point approximately 1500' SSE of the eastern corner of Rieves Bend at approximately mile 143.5 of the Duck River.

Three man-days were spent sampling the vegetation of the more densely forested areas and along the Duck River. Entry was gained into these areas by canoe. Seven man-days were spent sampling forest, field, and fence-row vegetation by walking in areas less accessible from the Duck River. About half of this time was spent examining the area within 1200' of the center of the study site.

In addition to on-site study, Dr. Elsie Quarterman and Dr. Robert Kral of Vanderbilt University, the two people who probably know the most about the flora of Central Tennessee, were contacted by telephone.

Topography

The topography varies from more or less flat in the northern and southwestern parts of the study area to somewhat rolling and dissected in a broad belt running from southeast to northwest. The elevation varies from a maximum of 760' above sea level in the southwest part of the area to 560' above sea level on the banks of the Duck River. Steep north-facing bluffs are found on the south side of Duck River at the eastern end of Rieves Bend and at Whitworth Bend. East-facing bluffs are found on the west side of Duck River at mile 143 near Negro Creek and at mile 142.6 to 142.8 of Whitworth Bend. The bluffs at these points are from 100' to 150' high and in some places the exposed limestone faces are nearly vertical. South-facing and west-facing bluffs on the north side of Duck River were noted but not sampled because they were on the perimeter of the site. Limestone outcrops and sinks are scattered throughout. Exposed limestone is also found along the steep banks of Fountain Creek and Silver Creek which meander through the southwestern sector of the study site.

The Central Area (1200 ft. Radius, about 100 Acres)

Rather open woods with cedars, hackberry, persimmon, winged elm, and black walnut as the most frequent trees cover about 55% to 60% of the area within 1200 feet of the center of the study area. Two small patches of woods of a more mature type with oaks and hickories dominating exist on the northwestern perimeter and about 500 feet due south of the center of the site. Four homesites occupy about 5% of the land. Two small ponds are found in the southwestern quadrant. A dirt road passes from east to west just south of the middle and a small road which dead-ends just north of the edge of the central area branches from the main road just south of mid-center and runs almost due north. Ragweed (Ambrosia) and horseweed (Erigeron canadensis) predominate along the roadsides. Fences separate fields and a small creek-bed runs southwest from the center of the site through a pasture to a small pond from which water is being pumped for the core-drilling operation. The older fence-row vegetation consists of rather sizable trees including cedar, winged elm, slippery elm, shingle oak, sassafras, black walnut and cherry. Cedar, hackberry and winged elm dominate younger fence-rows. A row of tree-of-heaven trees (Ailanthus) lines the upper part of the small creek.

One 6.5-acre field, 6% of the area, was sown in soy beans and millet. The rest, approximately 25% of the area, was in pasture. The most common weeds in the pastures are fine-leaved sneezeweed (Helenium tenuifolium), horseweed (Erigeron canadensis) and ragweed (Ambrosia Spp.). Wormwood (Artemisia) and ironweed (Vernonia) are also commonly found.

No rare or endangered species of vascular plants were found in the central 100 acres. Neither was any unique or rare habitat such as the "cedar glade habitat" found in this area.

The Outer Area (1 Mile Radius, about 2000 Acres)

Woods

About one-third of the study area is wooded. Most of the woods, as in the central area, are of a rather open type with cedars, hackberry, winged elm, and persimmon as the most frequent trees. Black walnut and honey locust are also rather common.

Along the steeper wooded banks of the Duck River and Fountain Creek, 3.4 miles and 1.6 miles respectively can be found a predominance of silver maple, green ash, and box-elder. Grape vines and dutchman's pipe vines are frequently draped over the trees. On gravel bars, where the intersection of the water with the banks of the river is less abrupt, willows predominate. Sycamores are more frequent on the gravel bars; however, they are also found on the steeper banks.

The most mature forested areas with oaks and hickories predominating are on the 120'-140' high north-facing bluffs of Rieves Bend to the north and northwest of the center of the site and approach to within 1200 feet of the center of the site. These woods cover an area about two-thirds of a mile long and from the top of the bluffs to the river. Similar vegetation occurs on about a half mile stretch north-facing and east-facing bluff of the Whitworth Bend region about two-thirds of a mile from the site center. South-facing and west-facing bluffs and creek valleys on the opposite side of Duck River between mile 143 and the

Negro Creek region, support a rather dense woods of elms, maples, and box-elders at the lower elevations, with oaks and hickories farther up the slopes from the river. This stand extends to within a little over a half mile from the site center to the northern perimeter of the study area. Smaller pockets of oak-hickory woods are found along the bluffs of Fountain Creek. These woods occupy at the most about 100 acres, 5% of the study area. They represent a remnant of the natural forest which once covered the area and are important reservoirs for natural reforestation of the region.

Fence rows

The fence-row vegetation is of three types, arborescent, shrubby, or herbaceous. The type seems to be dependent upon the age of the fence row with the arborescent type being the oldest and the herbaceous the youngest.

Most of the fence rows are arborescent. Cedar, hackberry, and winged elm are the most frequent trees. Slippery elm is not uncommon. In the oldest fence rows, mature cherries (*Prunus serotina*) and black walnuts are common. Sassafras, shingle oak, and persimmon are also notable.

Only on the penninsula between Rieves Bend and Whitworth Bend was a shrubby fence-row noted. It runs north and south between fields cultivated with hay, corn, Johnson grass, and soy beans. The fence-row is so densely overgrown with blackberry (*Rubus*) canes and honeysuckle vines (*Lonicera japonica*) that I doubt it will make a transition to an arborescent form.

Very few herbaceous fence rows were noted. These were populated with horseweed (*Erigeron canadensis*), thistle (*Cirsium altissima*), ragweed (*Ambrosia artemisiifolia*), evening primrose (*Oenothera biennis*), and goldenrod (*Solidago* sp.). Pokeweed (*Phytolacca americana*), jimsonweed (*Datura stramoneum*), morning-glory (*Ipomoea hederacea*) and may-pop (*Passiflora incarnata*) were also noted.

Fields

Fields were either cultivated, in pasture, or fallow. Pasture acreage totaled about 600 acres. The principal plants cultivated were corn (68 acres), millet and soy beans (16.5 acres), Johnson grass and soy beans (22 acres), lespedeza (5 acres), sorghum (2.5 acres), and tobacco (3 acres). Several large fields (131 acres) were used for growing hay. About 40 acres were identified as fallow fields. The uses of about 175 acres of fields southwest of Silver Creek were not identified.

Pastures were of varying quality. Depending upon the amount of grazing and care they received, they were more or less weedy with horseweed (*Erigeron canadensis*), fine-leaved sneezeweed (*Helenium tenuifolium*), ragweed (*Ambrosia* Spp.), and goldenrod (*Solidago* Sp.). Wormweed (*Artemisia*), ironweed (*Vernonia*) and horse-nettle were also notable in some pastures.

The weeds of the pasture were also commonly found at the edges of cultivated fields and along roadsides. One fallow field bordering Duck River had a dense cover of cocklebur (*Xanthium chinense*).

Exposed Limestone Outcrops

Special note was made of limestone outcrops because of the well-known presence in the Nashville Basin of a unique flora associated with exposed Lebanon limestone. This flora, known as the "Cedar Glade Flora," described by Dr. Elsie Quarterman (1950), includes species which are endemic to this habitat. Among them are several species of *Lesquerella* and *Leavenworthia* of the mustard family (*Cruciferae*) and several other herbaceous plants for a total of about sixteen endemic herbaceous species (Baskin, Quarterman, and Caudle, 1968). The physical factors associated with the development of a typical cedar glade are the presence of horizontal exposed limestone with rather poor drainage. On the limestone surface, a succession of plants occur as soil accumulates and becomes deeper. Under these conditions can be found a community of plants characteristic of the Tennessee Cedar Glades including the endemic plants mentioned above.

None of the exposed limestone sites examined within the study area exhibited the unique physical or vegetational characteristics of the Cedar Glades. Neither were any plants endemic to the Tennessee Cedar Glades found. Furthermore, no combination of plants characteristic of a cedar glade were found at any one limestone exposure. Nevertheless, one mile to the west of the perimeter of the study area just west of the Goose Creek on the Blue Springs Road a typical Tennessee Ceder Glade was found. A listing of some of the plants seen on that glade is appended to the list of plants found in the study area.

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Annotated List of Vascular Plants

A total of 473 specimens were collected in the Rieves Bend Area of Duck River. Numerous additional sight records were made. From the collections and sight records, a list of plants which includes representatives of 277 species of 204 genera of 83 families was made. Dr. Robert Kral of Vanderbilt, who has studied the flora of the Duck River basin rather extensively, says that 1,000 species of vascular plants occur in its drainage area (personal communication). His information is based on collections made at all seasons rather than over a two-week period late in the summer. It is unlikely, however, that additional work in the area throughout the year would much more than double the number of species which occur on our list. The possibility does exist, on the other hand, that rare or endangered spring-flowering plants were missed by our study of the area. Dr. Robert Kral suggests that none of the species of the Rieves Bend Area, other than those endemics of the Cedar Glades, are so narrowly endemic that they would be endangered by an installation which would disturb no more than the three-square-mile study area (personal communication).

Frequency and habitats of plants are noted following the name of the plant. Both represent personal judgments rather than a quantitative study. The frequency of plants are noted in the following order or decreasing occurrence: frequent, common, occasional, infrequent, and rare. The term "rare" means only that it is rare at the Rieves Bend Area at the time of the study. No generally recognized rare or endangered species were observed.

Acanthaceae

Dicliptera brachiata (Pursh.) Spreng.	Common	River banks
Justicia americana (L.) Vahl.	Common	In the river
Ruellia caroliniensis (Walter) Steudel.	Occasional	Woods

Aceraceae

Acer saccharinum L.	Common	River banks, Moist woods
Acer saccharum Marshall.	Common	Moist woods
Acer negundo L.	Common	River banks, Moist woods

Aizoaceae

Mollugo verticillata L.		Edge of cultivated field

Alismataceae

Sagittaria latifolia Willd.		Ponds

Amaranthaceae

Amaranthus hybridus L.	Common	Fields and barnyards
Iresine rhizomatosa Standl.	Occasional	Moist, open areas

	Anacardiaceae	
Rhus aromatica Ait.	Infrequent	Dry woods
Rhus copallina L.	Occasional	Edge of woods
Rhus glabra L.	Occasional	Roadsides, edge of woods
Rhus radicans L.	Frequent	Woods
	Anonaceae	
Asimina triloba (L.) Dunal.	Infrequent	Mixed woods
	Araceae	
Arisaema dracontium	Infrequent	Moist woods
Arisaema triphyllum (L.) Schott.	Infrequent	Moist woods
	Araliaceae	
Panax quinquefolium L.	Infrequent	Woods
	Aristolochiaceae	
Aristolochia tomentosa Sims.	Frequent	River banks
Asarum canadense L.	Occasional	Woods
	Asclepiadaceae	
Asclepias syriaca L.	Occasional	Old fields, roadsides

	Balsaminaceae	
Impatiens capensis Meerb.	Common	Moist woods
Impatiens pallida Nuttall.	Rare	Found in only one place
	Betulaceae	
Carpinus caroliniana Walter.	Frequent	Woods
Ostrya virginiana (Miller) K. Koch	Common	Woods
	Bignonaceae	
Bignonia capreolata L.	Common	Woods
Campsis radicans (L.) Seem.	Common	Open woods, fence rows
Catalpa speciosa Worder ex. Engeln.	Infrequent	Woods
	Boraginaceae	
Hackelia virginiana (L.) Johnst.	Infrequent	Woods
	Cactaceae	
Opuntia humifusa Raf.	Occasional	Open limestone outcrops, dry fields
	Campanulaceae	
Campanula americana L.	Infrequent	Woods
Lobelia siphilitica L.	Infrequent	Woods

Caprifoliaceae		
Lonicera japonica Thunberg.	Frequent	Open woods, fence rows, waste places
Sambucus canadensis L.	Occasional	Roadsides, mixed woods
Symphoricarpos orbiculatus Moench.	Frequent	Dry woods
Viburnum rufidulum Raf.	Infrequent	Woods
Caryophyllaceae		
Dianthus armeria L.	Infrequent	Roadsides
Celastraceae		
Euonymus americanus L.	Occasional	Woods
Chenopodiaceae		
Chenopodium album L.	Occasional	Barnyards, fields
Chenopodium ambrosioides L.	Occasional	Barnyards, fields
Commelinaceae		
Commelina communis L.	Infrequent	Open woods
Commelina erecta L.	Infrequent	Woods
Tradescantia virginiana L.	Infrequent	Woods

Compositae

Achillea millefolium L.	Common	Fields
Ambrosia artemisiifolia L.	Frequent	Fields and roadsides
Ambrosia trifida L.	Frequent	Fields and roadsides
Antennaria plantaginifolia (L.) Hook.	Common	Fields and open cedar woods
Artemisia annua L.	Frequent	Fields and roadsides
Aster cordifolius L.	Common	Open woods, fields, roadsides
Aster parviceps (Burgess) Mackenz. and Bush.	Common	Roadsides
Aster pilosus Willd.	Common	Woods
Aster shortii Lindl.	Common	Dry woods
Bidens bipinnata L.	Infrequent	Open grassy slope
Bidens polylepis Blake		
Chrysanthemum leucanthemum L.	Probably Common (ONE plant seen - flowered out of season)	
Cirsium altissimum	Common	Fields, road-sides, dry open woods
Eclipta alba (L.) Hassk.	Common	Wet, open areas
Elephantopus carolinianus Willd.	Common	Woods and edge of woods

Compositae (Continued)

Erechtites hieracifolia (L.) Raf.	ONE plant	Open area along a road
Erigeron canadensis	Infrequent	Fields and open cedar woods
Erigeron strigosus Muhl. ex Willd.	Infrequent	Fields and open cedar woods
Eupatorium coelestinum L.	Common	Fields and open cedar woods
Eupatorium incarnatum (Walt.)	Common	Moist woods
Eupatorium purpureum L.	ONE plant	Along roadside
Eupatorium rugosum Houtt.	Common	Fields
Eupatorium serotinum Michx.	Frequent	Fields
Gnaphalium obtusifolium L.	Infrequent	Fields and dry, open woods
Gutierrezia sarothrae (Pursh.) Britt. and Rusby.	Infrequent	Roadsides and fields
Helenium tenuifolium Nutt.	Frequent	Fields, open cedar woods
Helianthus decapetalus L.	Infrequent	Moist wooded bottoms
Hieracium venosum L.	Infrequent	Dry woods
Lactuca canadensis L.	Common	Open areas
Polymnia canadensis L.	Infrequent	Dry woods
Ratibida pinnata (Vent.) Bernh.	Infrequent	Roadsides
Rudbeckia hirta L.	Infrequent	Open woods, roadsides
Silphium perfoliatum L.	ONE plant	High on open river bank

Compositae (Continued)

Solidago flexicaulis L.	Infrequent	Woods
Solidago Sp.	Common	Fields
Tragopogon Sp.	Infrequent	Fields
Verbesina alternifolia (L.) Britton	Common	Moist woods, river banks
Verbesina helianthoides Michx.		Moist woods
Verbesina virginica L.	Common	Fence rows, edge of woods
Vernonia altissima Nuttall.	Common	Fields, open areas, river banks
Xanthium chinense Mill.	Infrequent -- except in a low field next to river where the entire field was covered with it	Low field next to river

Convolvulaceae

Cuscuta campestris Yuncker.	Infrequent	Open places
Ipomoea hederacea Jacq.	Infrequent	Open woods, fence rows
Ipomoea pandurata (L.) G.F.W. Meyer	Infrequent	Open woods, fence rows

Cornaceae

Cornus drummondii C. A. Meyer	Infrequent	Mixed woods
Cornus florida L.	Common	Oak-hickory woods
Nyssa sylvatica Marshall.	Occasional	Mixed woods

Crassulaceae

Sedum pulchellum Michx.	Infrequent	Rock outcrops
Sedum ternatum Michx.	Infrequent	Rock outcrops

Cruciferae

Lepidium virginicum L.	Occasional	Fields
Nasturtium officinale R. Br.	Found only in two shallow wet ditches	Shallow, wet ditches

Cucurbitaceae

Cucurbita Sp.	Found only near a pond	Near pond
Melothria pendula L.	Found only in an abandoned barn-yard thicket	Barnyard thicket
Sicyos angulatus L.	Found only in an open thicket on the Duck River bank	Open thicket

Cyperaceae

Carex complanata Torr. and Hook.		Wet ditch
Cyperus erythrorhizos Muhl.		
Cyperus esculentus L.		
Cyperus ovularis Michx.		Fields
Cyperus retrofractus (L.) Torr.	Occasional	Fields
Cyperus rivularis Kunth.		Wet ditch
Cyperus tenuifolius (Steudel.) Dandy		Wet ditch

Dioscoreaceae		
Dioscorea quaternata (Walt.) Gmel.	Occasional	Mixed woods
Ebenaceae		
Diospyros virginiana L.	Common	Fence rows, open woods
Euphorbiaceae		
Acalypha graciliens Gray.	Occasional	Open places
Acalypha virginica L.	Occasional	Open places
Crotonopsis elliptica Willd.	Occasional	Fields
Croton punctatus Jacquin	Occasional	Fields
Euphorbia dentata Michx.	Infrequent	Woods
Euphorbia supina Raf.	Occasional	Open limestone rock outcrops
Fagaceae		
Fagus grandifolia Ehrhart	Common	Mixed woods
Quercus alba L.	Common	Mixed woods
Quercus falcata Michx.	Occasional	Mixed woods
Quercus imbricaria Michx.	Occasional	Fence rows, margins of woods
Quercus muehlenbergii Engelm.	Occasional	Mixed woods
Quercus prinus L.	Common	Mixed woods
Quercus rubra L.	Common	Mixed woods
Quercus stellata Wang.	Occasional	Mixed woods
Quercus velutina Lam.	Occasional	Mixed woods

	Geraniaceae	
Geranium carolinianum L.	Common	Open places, roadsides
	Gramineae	
Arundinaria gigantea (Walt.) Chapm.	Occasional	River banks, moist woods
Echinochloa crusgalli (L.) Beauvois		
Panicum capillare L.		
Panicum lindheimeri Nash.		
Uniola latifolia	Common	River banks
Uniola sessiliflora Porret.	Infrequent	Mixed woods
	Guttiferae	
Ascyrum hypericoides L.	Infrequent	Dry woods
Hypericum punctatum Lam.	Infrequent	Dry, open woods
	Hippocastanaceae	
Aesculus glabra Willd.	Rare	Apparently planted on either side of an old driveway
Aesculus octandra Marsh.	Rare	Mixed woods

Hydrophyllaceae		
Hydrolea Sp.	Rare	Wet roadsides
Phacelia Sp.	Infrequent	Limestone rocks in woods
Juglandaceae		
Carya cordiformis (Wang.) K. Koch	Common	Mixed woods
Carya glabra (Mill.) Sweet	Common	Mixed woods
Carya ovata (Mill.) K. Koch	Common	Mixed woods
Juglans nigra L.	Common	Woods and fence rows
Juncaceae		
Juncus Sp.	Infrequent	Open cedar woods
Labiatae		
Agastache scrophulariaefolia (Willd.) Kuntze	Occasional	Mixed woods
Blephilia hirsuta (Pursh.) Benth.	Rare	Mixed woods
Collinsonia canadensis L.	Infrequent	Gravel bar
Lycopus Sp.	Rare	Wet ditch
Mentha piperita L.	Common	Barnyards, moist fields
Perilla frutescens (L.) Britton.	Occasional	Barnyards
Prunella vulgaris L.	Infrequent	Fields
Pycnanthemum pycnanthemoides (Leaven W.) Fern.	Occasional	Open places
Salvia lyrata L.	Occasional	Mixed woods
Scutellaria ovata Hill.		

Lauraceae		
Lindera benzoin (L.) Blume	Occasional	Mixed woods
Sassafras albidum (Nutt.) Nees	Occasional	Fence rows, dry woods
Leguminosae		
Amorpha fruticosa L.	Rare	Roadside next to Duck River
Amphicarpa bracteata (L.) Fernald	Rare	Dry ditch
Cassia fasciculata Michx.	Occasional	Fields and open cedar woods
Cassia nictitans L.	Occasional	Fields and open cedar woods
Cercis canadensis L.	Infrequent	Mixed woods
Desmanthus illinoensis (Michx.) MacM.	Rare	Roadsides
Desmodium glabellum (Michx.) DC	Occasional	Woods
Desmodium glutinosum (Muhl.) Wood.		
Desmodium illinoense Gray	Common	Fields
Desmodium laevigatum (Nutt.) DC	Occasional	Open mixed woods
Desmodium pauciflorium (Nutt.) DC		
Galactia volubilis (L.) Britt.	Rare	Open limestone
Gleditsia triacanthos L.	Common	Fence rows, open cedar woods
Lespedeza cuneata (Dumont) G. Don	Common	Roadsides, open areas
Lespedeza hirta (L.) Hornemann	Occasional	Open cedar woods
Lespedeza stipulacea Maxim.	Frequent	Fields

	Leguminosae (Continued)	
<u>Melilotus</u> <u>officinalis</u> (L.) Lam.	Infrequent	Roadsides
<u>Petalostemum</u> <u>purpureum</u> (Vent.) Rydb.	Infrequent	Roadsides
<u>Robinia</u> <u>pseudo-acacia</u> L.	Infrequent	Mixed woods
	Lemnaceae	
<u>Lemna</u> Sp.	Rare	Pond
	Liliaceae	
<u>Polygonatum</u> <u>biflorum</u> (Walter) Ell.	Infrequent	Mixed woods
<u>Smilax</u> <u>bona-nox</u> L.	Common	Woods
<u>Smilax</u> <u>rotundifolia</u> L.	Common	Woods
<u>Trillium</u> <u>erectum</u> L.	Rare	Mixed woods
<u>Yucca</u> <u>filamentosa</u> L.	Rare	Base of exposed limestone bluff
	Loganiaceae	
<u>Spigelia</u> <u>marilandica</u> L.	Infrequent	Mixed woods
	Lythraceae	
<u>Cuphea</u> <u>petiolata</u> (L.) Koehne	Infrequent	Edge of mixed woods
	Magnoliaceae	
<u>Liriodendron</u> <u>tulipifera</u> L.	Occasional	Patches of woods in fields, open woods

Malvaceae

Sida spinosa L.	Infrequent	Barnyards, fields

Menispermaceae

Cocculus carolinus (L.) DC	Infrequent	Mixed woods

Moraceae

Maclura pomifera (Raf.) Schneider	Occasional	Mixed woods
Morus rubra L.	Occasional	Mixed woods

Oleaceae

Fraxinus americana L.	Common	Mixed woods
Fraxinus pennsylvanica Marsh.	Common	River banks, moist woods
Fraxinus quadrangulata Michx.	Rare	Mixed woods
Forestiera ligustrina (Michx.) Poir.	Occasional	Dry woods
Ligustrum sinense Lour.	Infrequent	Open dry area

Onagraceae

Oenothera biennis L.	Occasional	Fence rows, roadsides

Ophioglossaceae

Botrychium dissectum L. var *tenuifolium* (Underw.) Farw.	Infrequent	Woods
Botrychium virginianum (L.) Sev.	Infrequent	Woods

	Orchidaceae	
Spiranthes gracilis (Bigel.) Beck	Infrequent	Open cedar woods
	Orobanchaceae	
Epifagus virginiana (L.) Barton	Occasional	Mixed woods
	Passifloraceae	
Passiflora incarnata L.	Occasional	Fence rows, open woods
Passiflora lutea L.	Rare	Woods
	Phrymaceae	
Phryma leptostachya L.	Rare	Mixed woods
	Phytolaccaceae	
Phytolacca americana L.	Occasional	Fence rows, barnyards, shrubby thickets
	Pinaceae	
Juniperus virginiana L.	Frequent	Fence rows, open woods, abandoned fields

Plantaginaceae

Plantago aristata Michx.	Occasional	Roadsides

Platanaceae

Platanus occidentalis L.	Common	River banks, gravel bars, moist woods

Polygonaceae

Polygonum hydropiperoides Michx.	Occasional	Moist, open places
Polygonum pennsylvanicum L.	Occasional	Moist, open places
Polygonum punctatum Ell.	Occasional	River bank, moist open places
Polygonum scandens L.	Occasional	Fence rows, abandoned fields
Rumex crispus L.	Occasional	Fields
Tovara virginiana (L.) Raf.	Occasional	River banks, moist woods

Polypodiaceae

Adiantum pedatum L.	Infrequent	Moist woods
Asplenium cryptolepis Fern.	Infrequent	Pockets in vertical limestone in woods

Polypodiaceae (Continued)

Asplenium platyneuron (L.) Oakes	Common	Mixed woods
Camptosorus rhizophyllus (L.) Link	Rare	On vertical limestone in mixed woods
Cheilanthes alabamensis (Buckley) Kunze.	Infrequent	Exposed limestone bluffs
Cystopteris bulbifera (L.) Bernh.	Infrequent	Cracks in limestone in mixed woods
Cystopteris fragilis (L.) Bernh.	Infrequent	Mixed woods
Pellaea atropurpurea (L.) Link	Infrequent	Exposed limestone
Phegopteris hexagonoptera (Michx.) Fee.	Infrequent	Mixed woods
Polypodium polypodioides (L.) Watt.	Infrequent	Mixed woods
Polystichum acrostichoides (Michx.) Schott.	Occasional	Mixed woods
Woodsia obtusa (Spreng.) Torr.	Occasional	Mixed woods, exposed limestone

Primulaceae

Samolus floribundus HBK.	Rare	Wet, wooded ravine

Ranunculaceae

Anemone virginiana L.	Occasional	Mixed woods
Clematis virginiana L.	Infrequent	Fence line, open thicket
Hepatica acutiloba DC.	Infrequent	Mixed woods
Thalictrum thalictroides (L.) Boivin		

Rhamnaceae

Rhamnus caroliniana Walter	Infrequent	Edge of woods, arborescent fence row

Rosaceae

Agrimonia gryposepala Wallr.	Occasional	Mixed woods
Crataegus crus-galli L.	Rare	Edge of oak-hickory woods
Fragaria virginiana Duchesne	Rare	Along road
Geum canadense Jacq.	Occasional	Mixed woods
Prunus augustifolia Marshall.	Infrequent	Open cedar woods
Prunus serotina Ehrh.	Occasional	Mixed woods, cedar woods, fence rows
Rosa carolina L.	Infrequent	Fence rows
Rosa eglanteria L.	Infrequent	Fence rows
Rosa setigera Michx.	Infrequent	Open field
Rubus occidentalis L.	Infrequent	Edge of dry woods in shallow soil
Rubus ostryifolius Rydb.	Common	Open areas, fence rows

Rubiaceae

Cephalanthus occidentalis L.	Infrequent	River banks, gravel bars
Diodia teres Walter	Occasional	Fields, gravel bars
Diodia virginiana L.	Infrequent	Moist, open places

	Rubiaceae (Continued)	
<u>Galium</u> <u>circaezans</u> Michx.	Occasional	Mixed woods
<u>Galium</u> <u>pilosum</u> Ait.		Limestone bluffs
<u>Houstonia</u> <u>purpurea</u> L.	Rare	Old roadsides
	Rutaceae	
<u>Ptelea</u> <u>trifoliata</u> L.	Occasional	Mixed woods
	Salicaceae	
<u>Populus</u> <u>deltoides</u> Marsh.	Rare	One 4' specimen seen on gravel bar
<u>Salix</u> <u>nigra</u> L.	Common	Gravel bars, ponds
	Saxifragaceae	
<u>Heuchera</u> <u>villosa</u> Michx.	Infrequent	Limestone outcrops
<u>Hydrangea</u> <u>arborescens</u> L.	Occasional	Woods
<u>Philadelphus</u> <u>hirsutus</u> Nutt.		
<u>Saxifraga</u> <u>virginiensis</u> Michx.	Infrequent	Limestone in mixed woods
	Scrophulariaceae	
<u>Lindernia</u> <u>dubia</u> (L.) Pennell	Infrequent	Edge of ponds
<u>Penstemon</u> <u>digitalis</u> Nutt.		Roadsides
<u>Scrophularia</u> <u>marilandica</u> L.	Infrequent	Mixed woods
<u>Verbascum</u> <u>blattaria</u> L.	Infrequent	Barnyards
<u>Verbascum</u> <u>thapsus</u> L.	Infrequent	Open cedar woods

	Simaroubaceae	
Ailanthus altissima (Miller) Swingle	Infrequent	Fence rows, creek banks
	Solanaceae	
Datura stramonium L.	Infrequent	Fence rows
Physalis angulata L.	Infrequent	Edge of cultivated field
Physalis heterophylla Nees.	Infrequent	
Solanum carolinense L.	Common	Fields and open cedar woods
Solanum nigrum L.	Occasional	Fields
	Staphylenceae	
Staphylea trifolia L.	Infrequent	Mixed woods
	Tiliaceae	
Tilia americana L.	Occasional	Mixed woods
	Typhaceae	
Typha latifolia L.	Infrequent	Pond margins, wet ditches
	Ulmaceae	
Celtis laevigata Willd.	Frequent	Fence rows, cedar woods, wooded bottoms, old fields

	Ulmaceae (Continued)	
Ulmus alata Michx.	Frequent	Fence rows, cedar woods, old fields
Ulmus rubra Muhl.	Common	Fence rows, cedar woods, wooded bottoms, mixed woods
	Umbelliferae	
Cryptotaenia canadensis (L.) DC	Infrequent	Mixed woods, bottoms
Daucus carota L.	Common	Roadsides, fields
Sanicula canadensis L.	Infrequent	Mixed woods, bottoms
	Urticaceae	
Laportea canadensis (L.) Wedd.	Common	Moist woods, bottoms
Pilea pumila (L.) Gray	Common	Moist woods, bottoms
	Verbenaceae	
Callicarpa americana L.	Rare	Mixed woods
Lippia lanceolata Michx.	Infrequent	Gravel bars, pond margins
Verbena simplex Lehm.	Occasional	Fields, open cedar woods
Verbena urticifolia L.	Occasional	Fields, open cedar woods

Vitaceae

Parthenocissis quinquefolia (L.) Planch.	Common	Woods
Vitis aestivalis Michx.	Common	Woods
Vitis baileyana Monson	Common	Woods

ADDENDUM

Cedar Glade Plants

Asclepiadaceae:	Asclepias verticillata L.
Cyperaceae:	Cyperus inflexus Muhl.
Leguminosae:	Petalostemum gattingeri Heller
Portulacaceae:	Talinum calcaricum Ware

Dr. Gordon E. Hunter, Chairman
Department of Biology
Tennessee Technological University
Cookeville, Tennessee 38501

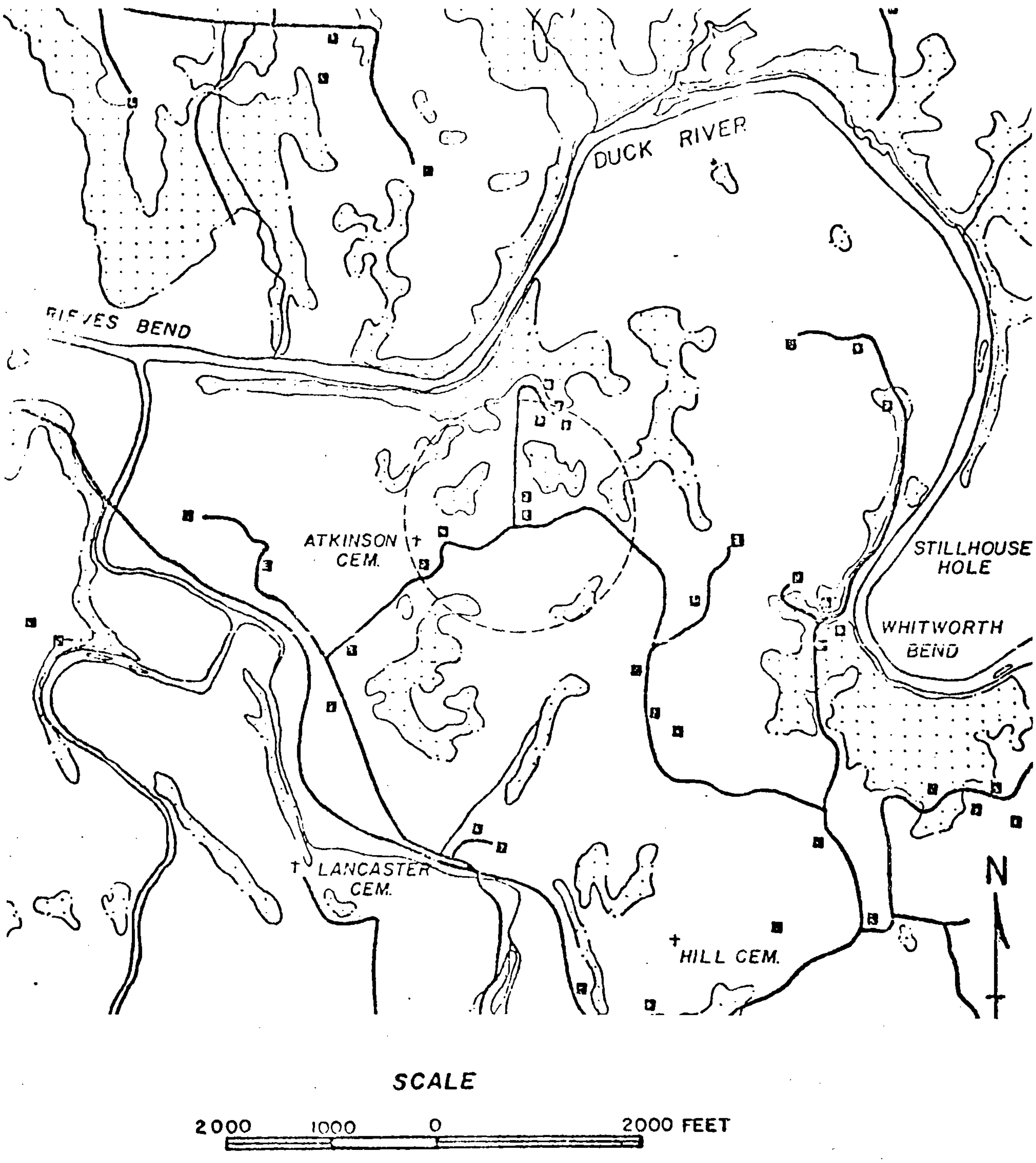
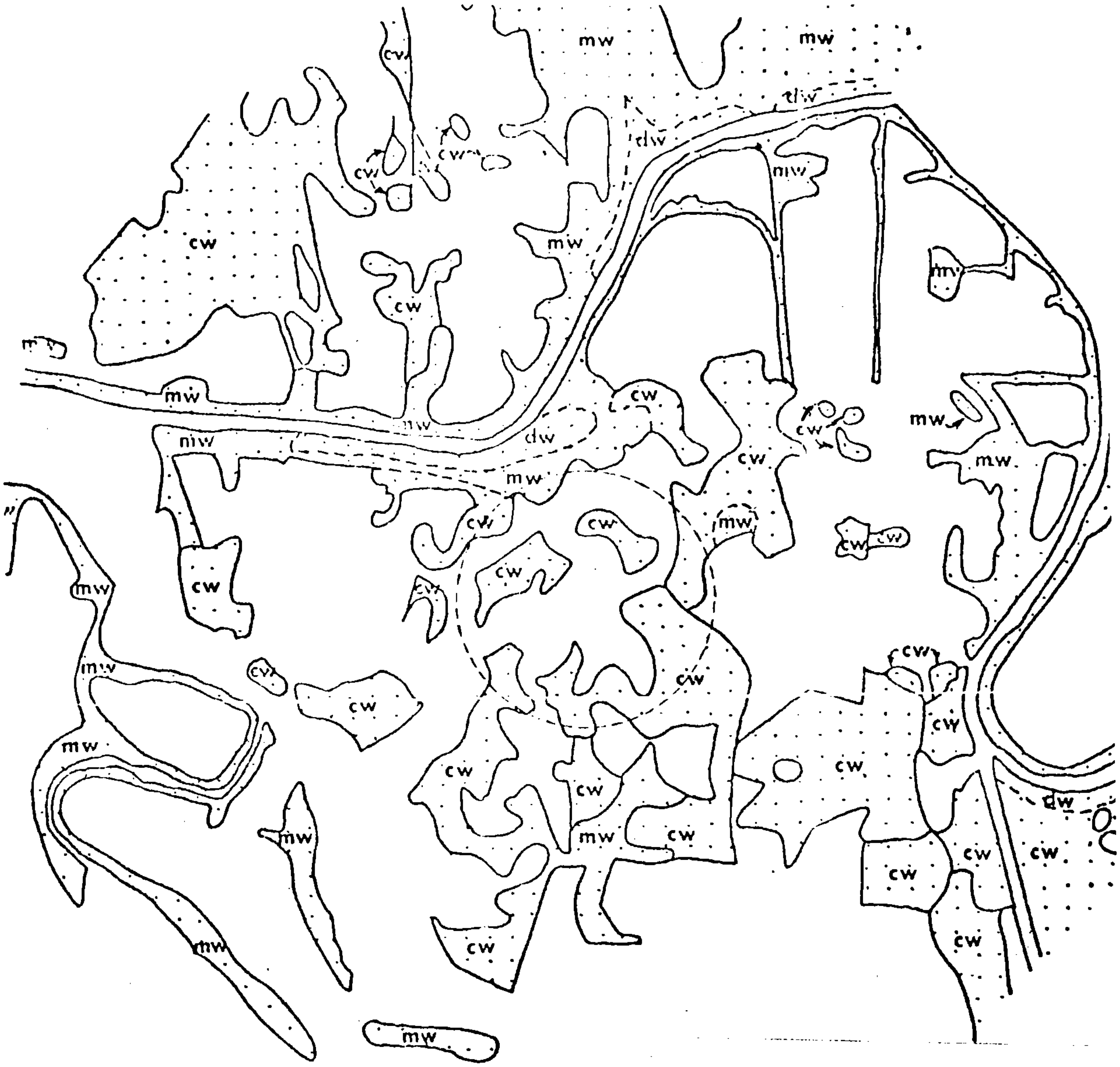


Figure 1 RIEVES BEND AREA (DUCK RIVER) -- GLENDALE QUADRANGLE, TENNESSEE

c = corn
f = fallow
h = hay
hs = home site
jgs = johnson grass and soy beans
l = lespedeza

m = millet
O = open field
p = pasture
s = sorghum
sbm = soy beans and millet
t = tobacco

Figure 2 LAND USE, RIEVES BEND AREA



cw = cedar woods
dw = dense woods
mw = mixed deciduous woods

Figure 3 FORESTED AREA, RIEVES BEND SITE

APPENDIX B

ENVIRONMENTAL EFFECTS ASSOCIATED
WITH THE HYPOTHETICAL CORE
DISRUPTIVE ACCIDENT (HCDA) --

RESPONSE TO ATOMIC ENERGY COMMISSION QUESTION 000.16 (7.1)

1.0 INTRODUCTION

The precedents (EBRI, EBRII, FERMII, SEFOR, FFTF) to the CRBRP in safety evaulation for fast reactors have evaluated accidents which involved severe core damage and release of core fission product inventory. These were utilized in evaluating the adequacy of the containment design and the results were compared to the guidelines of 10 CFR 100. Significant design and development efforts are being implemented on the CRBRP project to support the judgment that accidents such as the HCDA, which involve severe core damage, are low enough in probability that they need not be considered in the design bases for the CRBRP. The reliability efforts described in Appendix C of the PSAR will confirm the HCDA to be in the Class 9 category, thus removing the environmental effects of such an accident from consideration by the provisions of Appendix D to 10 CFR 50. However, recognizing that the data base to fully support this position is still being developed, a parallel design for CRBRP is being developed which includes core disruptive accidents in the plant design bases. It should further be recognized that the Parallel Design requires an extensive R&D effort, at least as substantial as the effort required for the reference design. The features of this parallel design are described and accident evaluations for this design basis are included in Appendix F of the PSAR. The analyses presented in this appendix to the ER are applicable to a parallel design including an ex-vessel core catcher and a sealed head access area.

The core disruptive accidents which are evaluated are hypothetical accidents since they postulate the complete failure of the redundant shutdown systems concurrently with the malfunction of components and/or occurrence of events leading to a serious power-flow mismatch in the core. The probability of exceeding 10 CFR 100 guidelines or a consequence of a failure path involving failure to scram will be about one chance in 10 million per year, as indicated in the reliability program of Appendix C.

Preliminary evaluations already show the shutdown system failure probability to be even lower than this target value.

Two postulated accident sequences have been analyzed - the core damage consequences for the nominal Transient Overpower (TOP) HCDA and the nominal loss of flow (LOF) HCDA. This nominal treatment is in keeping with the approach utilized for evaluating the sequences of accidents for the ER. The damage consequences evaluated in this ER appendix for the TOP sequence correspond to the nominal TOP case of Appendix D of the PSAR. The LOF sequence evaluated is based on the analyses in Appendix D of the PSAR up to the point where the phenomena predicted by the computer codes are judged to remain physically realizable. Beyond this point, the sequence is evaluated in the light of best current scientific understanding of the controlling physical phenomena. These phenomena and their expected applicability are discussed in Section 1.2 of this Appendix.

1.1 HCDA INITIATORS

The postulated initial conditions that would provide mechanisms for core disruption can be classified into two broad categories; reactivity insertions and reduced core cooling. In all cases, these mechanisms must be coupled with a complete failure of the reliable, redundant and diverse shutdown systems before a core disruptive accident could be postulated.

1.1.1 REACTIVITY INSERTIONS

During normal power operation, the excess reactivity is controlled by control rods while the core geometry is maintained by a core restraint system. Failure mechanisms can be identified with the moveable control rods or with the structures maintaining core geometry, which would result in reactivity insertions. There are other less probable mechanisms, such as gas bubble entrainment in the coolant, which could be postulated to introduce reactivity. The largest reactivity insertions are associated with a control rod withdrawal; the maximum worth of a control rod is $3.20. The reactor protection system is designed with redundancy and diversity to shutdown the reactor reliably and protect the system against the consequences of reactivity insertions. Speed of response requirements assure that any reactivity insertions can be arrested and a coolable core geometry maintained.

1.1.2 REDUCED CORE COOLING

Loss of cooling to the core would result in overheating of fuel and structures and possibly voiding of coolant from the core region. The reactivity effects of voiding and the structural damage of the core could be substantial, depending on the extent and duration of the flow reduction. Potential causes of reduced core cooling include electrical or mechanical failures within the Heat Transport System. The heat removal systems and the Reactor Protection System are designed to assure shutdown of the reactor to provide protection against such reduced cooling events.

Sodium leaks of sufficient magnitude to cause core damage independent of reactor shutdown are of exceedingly low probability, and their consequences (recognizing that the reactor would be subcritical) would be enveloped by the loss-of-flow analyses presented below.

1.1.3 INITIAL CONDITIONS FOR HCDA ANALYSIS

The HCDA analyses in Appendix D to the PSAR include both the reactivity insertion and coolant reduction initiating sequences without scram. The reactivity initiating events considered are those that can be mechanically postulated to occur, recognizing that they are of low probability. These events have been determined to have modest reactivity insertion rates of 2 to 20 cents per second and a total maximum reactivity worth of $3.20, which is the maximum worth of a control rod. The 2 cents per second is a nominal value for rod withdrawal at normal speed and 20¢ per second is the limiting rate beyond which the certrifugal force in the control rod drive mechanism would release the latch and cause the rod to drop into the core.

The reduced coolant initiating sequence is based on flow coastdown resulting from loss of power to all pumps. Sodium leaks of sufficient magnitude to cause core coolant flow reductions more rapid than the pump coastdown are extremely improbable and it would not be appropriate to combine these events with failure of the Reactor Protection System.

The Appendix D PSAR analyses are based on the above two initiating sequences; each combined with postulated failures of the two reliable independent and diverse shutdown systems.

1.2 HCDA SEQUENCES

The predictions of the physical phenomena associated with either the loss of flow (LOF) HCDA or the transient overpower (TOP) HCDA (both without scram) are based on theoretical models and experimental evidence related to the thermodynamic and mechanical effects predicted. The complexity of the accident is such that a wide spectrum of sequences can be theorized. The HCDA evaluations being performed by the CRBRP project are directed toward identification of the more probable sequences. Sensitivity analyses have been performed to evaluate the effects of the most important uncertainties in the analyses. The results available to date are reported in Appendix D of the PSAR. These analyses are supplemented by and interpreted in the light of judgment based on continually improving understanding of the controlling physical phenomena.

All HCDA analyses have the character of failing the fuel cladding in a portion of the core and melting cladding, fuel, or both materials in a portion of the core. There are some critical differences in the detail of fuel failure depending whether it is a TOP-HCDA or LOF-HCDA. Table B-1 presents a descriptive chronology of the TOP-HCDA and Table B-2 presents a similar description for the LOF-HCDA, both of which are predicted by the SAS[1] computer code coupled with engineering judgment.

The SAS/VENUS II[2] codes represent the current state of computational technology in the HCDA area and as such have been utilized to perform the HCDA studies in Appendix D to the PSAR. These codes, however, have limitations in their ability to mechanistically predict the entire course of a core disruptive event. The clad and fuel motion models in the SAS code have a limited range of applicability and therefore the SAS analyses represent only a portion of the information necessary to establish the HCDA design basis for the parallel design. Appendix F to the PSAR will provide the supplementary analysis and the rationale for establishing HCDA bases. An important part of the rationale involves consideration of the probability and significance of recriticality and thermal phenomena in the time period greater than 100 milli-seconds into a rapid power transient. Some insight is given to this time period in Appendix D to the PSAR, but greater detail is required to support the choice of HCDA design bases. This will be provided in Appendix F to the PSAR.

It is possible at this stage to utilize the information of PSAR Appendix D along with engineering judgment to arrive at a characterization of the consequences consistent with the intent of the requirements in Appendix D to 10 CFR 50.

Table B-1 presents the nominal sequence for the TOP case. After evaluating the TOP analyses reported in Appendix D in the light of engineering judgment and best understanding of the physical processes involved (such as the location and nature of the fuel failure and subsequent fuel motion which results in permanent shutdown of the reactor), it has been concluded that this is an appropriate nominal case.

Table B-2 presents the nominal sequence of events for a LOF-HCDA. The analyses reported in Appendix D to the PSAR indicate that it is possible to calculate that the initiating sequence could lead to energetic disassembly of the core. These analyses predict energetics that exceed any believed to be physically realizable. The SAS models currently used to predict clad motion in a voided channel and fuel motion following pin failure in a channel prior to boiling provide unrealistically conservative estimates of the reactivity feedback effects due to these phenomena. The clad motion model predicts a more rapid and complete loss of clad material from the active core than is believed to be physically realizable. Likewise, the fuel-coolant interaction model predicts considerably greater fuel motion toward the core centerline from a rupture above the centerline than is believed to occur. The conservatively estimated positive reactivity effects from these two phenomena combine to yield considerably larger reactivity ramp rates at the onset of core disruption and, consequently, much higher energy releases, than would be obtained from a more realistic treatment.

When assumptions are made which are more consistent with the best scientific understanding of the phenomena, reactivity ramps sufficient to energetically disassemble the core would not be expected to occur in the initiating sequence. As the core disruption proceeds, it is characterized by relatively mild dispersive mechanisms that tend to preclude the potential for recriticality and energetic excursions. Following gross core involvement in melting and possible mild excursions, clad boiling and fuel melting would disperse the core material into a noncritical configuration. Continued decay heating would cause further core melting and the molten core materials would boil up and fill the available volume. If paths are available through the upper structure, material would begin to be ejected into the upper sodium pool. If the passages are blocked, rapid melting attack on the upper structures would begin, allowing ejection of molten core materials into the above-core sodium. This upward fuel removal should occur on a short-time scale compared to the time required to melt down through the lower subassembly structure. This ejection should have little or no damage potential and the materials will mix with the above-core sodium pool and come to rest upon the upper internals where some capability for cooling exists. The remaining core materials would eventually come to rest and be cooled on the lower internal structures or would melt through the vessel and be contained in the ex-vessel core catcher.

In summary, therefore, the considerations discussed support the loss-of-flow accident sequence leading to gradual fuel dispersal with little or no work potential. The time scale for these events is such that melt-through of the core support structure and the reactor vessel cannot be precluded at this time. However, the declared intention of the project is to enhance post accident heat removal capability of the core support structure.

This low energetic meltdown course of the LOF-HCDA is considered to be a more credible sequence of events than direct disassembly. Therefore, it has been chosen as the nominal case for the LOF and the consequences evaluated here are associated with this path.

1.3 HCDA ENVIRONMENTAL IMPACT

During an HCDA, fractions of the four major fission product groups (noble gases, halogens, volatile solids and solids) would be released to the sodium coolant along with a fraction of the fuel material including plutonium. The release from the coolant into primary system gas spaces can be expected to be much less for halogens and particulates than for noble gases.

The damaged core materials from the nominal TOP-HCDA would be contained within the primary coolant boundary since little molten fuel is released from the cladding. In this case, the fission product release from the primary system would be small and confined to noble gas leakage through minor existing cover gas seal leak paths. The release of a major part of the fission products and fuel material would not occur.

For the LOF-HCDA sequence analyzed, where a large fraction of the fuel in the core is predicted to become molten, analyses to date based on the present reference design of the core support structure do not assure that the molten fuel will be contained within the primary coolant boundary but may possibly melt through the reactor vessel. In that case, the accident products would be contained in an external core catcher.

1.3.1 MATERIAL LEAK PATHS

1.3.1.1 NOMINAL TOP-HCDA

The material leak paths and leak rates considered in the nominal TOP-HCDA analyses are indicated in Table B-3.

The primary coolant boundary would not be damaged by the nominal TOP-HCDA and the core materials would be cooled within the vessel. The release of fission gas from damaged fuel assemblies would provide a slight pressurization of the cover gas ($\sim$1 psig) which would cause somewhat higher than normal leak rates through the seals in the head. A tortuous leak path has been provided from the bottom of the head to the head access area seals, including a liquid sodium dip seal and two buffered inflatable seals. In the event of a pressurization of the cover gas, the buffered inflatable seals are protected by the dip seals in that the sodium in the dip seals will not be displaced to the elevation of the buffered seals during the postulated events. Any small leakage of cover gas and noble gases would enter the head access area. In the Reference Design, this area is not sealed and any leakage through the head seals would be into the Reactor Containment Building.

A design option in the Parallel Design is a Sealed Head Access Area (SHAA) which would provide an additional barrier to leakage. It could be designed with either an air-filled or inerted environment. Its design leak rate is 100% vol/day at the design pressure (which will depend on the environment). It is currently estimated that the design pressure with an inerted environment would be approximately 35 psig. The environmental consequences would not be sensitive to the selection of the SHAA atmosphere since no sodium is expected to leak into the SHAA. Following an HCDA, the SHAA would be isolated and is estimated to heat up to approximately 400 degrees F. This heatup would provide a driving pressure of about 10 psig and result in some leakage from the SHAA to the Reactor Containment Building (RCB). The slow leakage of gases through the head seals would not pressurize the SHAA.

The materials which leak from the head access area to the RCB are assumed to leak from the RCB based on a driving pressure of 0.5 psig. No direct means of pressurization is evident; this driving pressure allows for possible variations in atmospheric pressure outside the containment and some heatup of the building atmosphere following shutdown of the ventilation system and isolation of the containment. The design leak rate of the RCB is 0.1% vol/day at 10 psig. Using the relationship that leakage is proportional to $\sqrt{\Delta p}$, the fractional leak rate at 0.5 psig would be 2.6×10^{-9}/second.

1.3.1.2 NOMINAL LOF-HCDA

The material leak paths and leak rates considered in the nominal LOF-HCDA analyses are indicated in Table B-4. The analyses considered one case in which the materials were cooled within the reactor vessel and another case in which a melt-through of the reactor vessel was considered and the core materials would be contained within an ex-vessel core catcher, which is presumed to function in accordance with its requirements.

For the case in which the materials are contained within the reactor vessel, the primary coolant boundary would not be damaged. No high pressure would be expected to act on the head seals. The release of 100 percent of the fission gas from all of the fuel would only pressurize the cover gas to approximately 12 psig. While this could produce higher than normal leakage through the head seals, the seals would not be damaged. High temperature gases and vapors that enter the cover gas would not impinge directly on the seals since the cover gas would provide a buffer. These contaminants of the cover gas would be cooled quickly by the sodium pool so that no long term high temperatures would be expected. The leakage through the head seals would enter the head access area, which is open to the containment in the Reference Design. Leakage from the containment is considered based on a driving pressure of 0.5 psig, as discussed in the TOP cases.

For the case in which the materials are considered to melt through the reactor vessel, additional leak paths must be considered. The release of the core materials and sodium into the reactor cavity is assumed to pressurize the cavity to 35 psig initially. In the Parallel Design, the leak rate of materials out of the reactor cavity is expected to be limited to 100% vol/day by design requirements. This leak rate is used initially and decreased according to the $\sqrt{\Delta p}$ relationship as the cavity materials leak. The leakage would be expected to be largely into the Heat Transport System (HTS) cells through the large piping penetrations between the Reactor Cavity and the HTS cells. Although some of the leakage could be into the SHAA, it is somewhat conservative to assume that all of the reactor cavity leakage is into the HTS cells, and this assumption was used.

For materials which leak into the HTS cells, leakage from the cells to the RCB was assumed to occur at 100% vol/day for the duration of the accident. Although these cells do not have a design leakage requirement for accident conditions, the normal operating requirements assure that the cells will have a leaktightness to maintain their inerted atmosphere. The concrete cells are steel-lined to provide low leakage. No source of pressurization of the HTS cells is expected following the nominal LOF-HCDA and the low leakage is expected to be maintained. Fallout and plateout of aerosol materials is considered in the HTS cells using the HAA-3[(3)] computer code.

The materials entering the SHAA are assumed to leak into the RCB based on a driving pressure of 10 psig. This pressure allows for heatup of the SHAA to approximately 400 degrees F following isolation. The fallout and plateout of aerosols in the SHAA is considered using the HAA-3 computer code.

The materials which leak from either the SHAA or the HTS cells into the RCB are assumed to leak from the RCB based on a driving pressure 0.5 psig, as discussed for the previous cases. Again, there is no direct source of pressurization that can be identified and this driving pressure allows for possible variations in atmospheric pressure and some heatup of the building atmosphere following shutdown of the ventilation system and isolation of the RCB. The fallout and plateout of aerosols in the RCB is considered using the HAA-3 computer code.

It should be noted that these multiple barriers with small leakage paths and low pressure differentials probably would not leak significant fractions of particulate material. However, this analysis assumes that the aerosols leak like gases, as has been the traditional conservative assumption. The degree to which this assumption is conservative cannot be quantified at this time.

1.3.2 SOURCE TERM FOR NOMINAL TOP-HCDA

The end of equilibrium cycle TOP-HCDA results in damage to 6 percent of the fuel assemblies. No significant pressure pulses are predicted and no damage to the primary coolant boundary, including seals, is expected for this event. It was assumed that all the noble gases in the damaged assemblies were released to the primary sodium coolant and thus to the cover gas region. Any halogens or solid fission products released would be captured in the primary sodium or would be held up in the cover gas and not leak through the intact head seals to reach the RCB. To account for buildup of noble gases from hologen decay, the noble gas daughter-products of 50 percent of the halogens in the failed fuel assemblies (3% of the core inventory) were included in the computation of leakage from the reactor cover gas to the containment atmosphere.

Since the event does not result in any structural damage to the primary coolant boundary, release of the noble gases to the RCB would be through normal small leakage paths in the vessel head seals. The design head seal leak rate is 0.012 scc/min. at a cover gas pressure of 15 psia with a Δp across the seals of 0.3 psi. To estimate the release rate through the head seals following this event, 6 percent of the noble gases in the End of Equilibrium cycle (EOEC) core (6.40×10^5 scc) were released to the argon cover gas volume 1.25×10^7 scc. The addition of 6.40×10^5 scc of noble gases to the 1.25×10^7 of argon cover gas at a constant volume in the cover gas region would increase the cover gas pressure to 15.7 psia. The Δp across the head seals would then be 1.0 psi. Leakage through the head would be through very small leakage paths and it was assumed that the leakage would vary linearly with the Δp across the leak paths. Using this Δp relationship, the 3.3 fold Δp increase (0.3-1.0 psig) results in an initial leak rate of 0.04 scc/min. This rate was conservatively applied for the duration of the accident. The fractional leak rate from the cover gas region was 4.4×10^{-11} sec^{-1}.

A case was also analyzed with a Sealed Head Access Area (SHAA) which had a design leak rate of 100% vol/day at 35 psig (Parallel Design Case). In this case, the SHAA temperature was assumed to increase to 400 degrees F due to heat up following isolation of the area. The SHAA pressure would then be $\sim$10 psig. The pressure and associated leakage rate in the SHAA as a function of time was calculated assuming the leak rate varied as $\sqrt{\Delta p}$. The initial leak rate was 6.06×10^{-6}/sec, which decreased to 6.18×10^{-7}/sec ($\Delta p \simeq 0.1$ psig) in 9.3 days and to 1.9×10^{-7}/sec ($\Delta p \simeq 0.01$ psig) in 30 days.

1.3.3 SOURCE TERM FOR LOF-HCDA

In the absence of a rigorously calculated composition of a realistic source term of a LOF-HCDA, a conservative approach was taken to characterize the source term. Since it is possible to envision local pockets of high power density and temperature in the molten core, it is possible that a few percent of the fuel material could be in the vapor phase. In this analysis, it has been conservatively assumed that the molten fuel material had 6 percent vapor phase associated with it. This fuel vapor should quickly condense as it passes through the sodium pool during expulsion. However, the expulsion process should be quite vigorous and rapid, and thus some of the fuel vapor could be swept through the sodium pool without sufficient contact with the sodium to complete the condensation. Since detailed calculations have not been performed to determine transport times and heat transfer rates associated with the condensation process during the vigorous expulsion, it has been conservatively assumed that 100 percent of the core noble gas inventory temporarily remains in the molten core. This provides a semi-mechanistic conservative means to transport the fuel vapor material through the sodium pool. It should be recognized that the noble gases would probably be released to the cover gas well before this time.

The radiological consequences of the accident were analyzed assuming that a fraction of the core inventory of fuel and fission products is carried to the cover gas region with the noble gases and there they leak to the RCB at a rate based on the design leak rate for the head seals and pressurization from the gas release. The fractions of fuel and fission products carried to the cover gas are determined by volume weighting. One case analyzed for the LOF-HCDA assumed that the accident is contained in-vessel and that the head access area is open. A case was also run which evaluated the radiological consequences of melt-through and containment in an ex-vessel core catcher and including a sealed head access area. The leak rate of the SHAA was the same as calculated for the nominal TOP case (Section 1.3.2).

1.3.3.1 FRACTION OF CORE MATERIAL RELEASED TO COVER GAS REGION

1.3.3.1.1 FUEL MATERIAL

Based on the assumptions discussed in the foregoing, the molten core contains 504 kg (4.11 lb moles) of vaporized fuel and 1.05 pound moles of noble gases. Assuming that the noble gases shield the fuel vapor from condensation in proportion to the relative volumes, 20 percent of the vaporized fuel and other suspended material would be carried to the cover gas region as an aerosol. Thus, 1.2 percent of the core fuel, containing 25 kg of PuO_2, is assumed to be released to the cover gas region as an aerosol.

1.3.3.1.2 HALOGENS

One hundred percent of the halogens would be released from the vaporized fuel and 50 percent would be released from the molten fuel and form an aerosol with the condensing fuel. Thus 6.0 percent of the core inventory of halogens is released with the fuel vapor and 46.8 percent from the molten fuel. A total of 52.8 percent of the total core inventory of halogens is initially present as a potential aerosol; 20 percent of these are assumed to be carried to the cover gas region with the non-condensable noble gases. This results in the release of 10.6 percent of the core inventory of halogens to the cover gas region as an aerosol.

1.3.3.1.3 SOLID FISSION PRODUCTS

The solid fission products will in general stay with the fuel material. Six percent will be in the bubble with the vaporized fuel. Based on data reported by Idaho Nuclear Corporation,[4] 1 percent of the solid fission products could be released from the molten fuel. This releases an additional 0.93 percent of the core inventory of solid fission products. The total inventory of solid fission products available for transport to the cover gas would be 7.0 percent of the core inventory. The noble gases carry 20 percent of these (1.4% of the core inventory) to cover gas region.

1.3.3.2 RADIOLOGICAL RELEASE TO REACTOR COVER GAS REGION

The above model for release of core materials results in the following release of radioactive material to the cover gas region.

Noble gases	100%
Halogens	10.6%
Solid Fission Products	1.4%
Fuel Material	1.2% (25 kg of PuO_2 in 100 kg fuel)

1.3.3.3 LEAKAGE FROM THE COVER GAS REGION

The radiological consequences of this accident were estimated on the basis that the leakage through the head seals varies linearly with the Δp across these seals. The design leak rate is 0.012 scc/min at a Δp of 0.3 psi. The cover gas pressure following release of 100 percent of the noble gases in the core would be 26.6 psia. The initial fractional leak rate was calculated to be 6×10^{-10} sec^{-1}. With this small leak rate, the cover gas pressure would be reduced very slowly due to leakage and the leak rate was taken as 6×10^{-10} sec^{-1} for the duration of the accident.

1.3.3.4 ANALYSIS OF RADIOLOGICAL CONSEQUENCES OF MELT-THROUGH OF THE REACTOR VESSEL

If the internal debris retention capability is insufficient, the debris could eventually melt-through the vessel, and would then be retained in the ex-vessel core catcher below the reactor vessel within the reactor cavity region. The reactor cavity and Sealed Head Access Area (SHAA) in the Parallel Design are designed for 100%/day leak rate at 35 psig. Release of fission products to the reactor cavity will occur during the period of reactor vessel melt-through and retention in the core catcher. Leakage from the vessel cavity would be to the adjacent Heat Transport System cells and to the SHAA. The leak rate of the cells and SHAA was taken to be 100%/day for the duration of the accident. Leakage from the vessel cavity was calculated assuming that the cavity was initially pressurized to 35 psig and that the pressure decrease with time was due only to leakage at the design rate of 100%/day at 35 psig. The leak rate was assumed to vary as $\sqrt{\Delta p}$.

To determine the concentration of radioactive material in the vessel cavity and SHAA atmosphere, the following sequence was postulated for the melt-through. Following the LOF-HCDA, 100 percent of the core fuel material containing 100 percent of the end-of-life equilibrium core inventory of solid fission products and halogens melt through the reactor vessel and guard vessel and is contained in an ex-vessel core catcher. This core catcher contains the fuel material cooled by sodium such that bulk boiling of the sodium does not occur. Some of the volatile fission products may escape to the vessel cavity during this period but this will not affect the results significantly since these will contribute to the equilibrium concentration which will be established between the isotopes in the sodium and in the atmosphere.

One hundred percent of the initial inventory of noble gases is released via this path since they were all released to the cover gas in the initial phases of the HCDA prior to melt-through but only a small fraction would leak from the vessel before melt-through. Noble gas daughters which result from decay of solid fission products are accounted for by assuming all the noble gas precursors decay (except very long-lived ones) and the daughter noble gases are released to the vessel cavity and SHAA as an initial concentration.

Solid fission products which were considered for this phase of the accident were the isotopes of cesium, rubidium, iodine, strontium and barium. These isotopes were assumed to be released from the fuel and mixed with 826,000 pounds of primary sodium at 1200 degrees F which drains from the vessel to the vessel cavity and core catcher. The equilibrium concentration in the atmosphere above the sodium pool was determined according to the following relationships which are based on data published by Castleman,[5] Catton[6] and Kunkel.[7]

$$S_{Cs} = 1.5 \times 10^{-9} f_{Cs} A_{Cs}$$

$$S_{Rb} = 1.0 \times 10^{-9} f_{Rb} A_{Rb}$$

$$S_{I} = 1.6 \times 10^{-11} f_{I} A_{I}$$

$$S_{Sr} = 9.2 \times 10^{-13} f_{Sr} A_{Sr}$$

$$S_{Ba} = 4.5 \times 10^{-4} f_{Ba} A_{Ba}$$

where:

S = Equilibrium concentration in gas (Ci/l)
f = Fraction released from fuel to sodium
A = Activity in fuel in core catcher (Ci)

It was conservatively assumed that 100 percent of the fission products considered were released from the fuel to the sodium (f = 1). Because of the very low volatility of the fuel material when it is mixed with sodium, no appreciable source term from the fuel would result.

Based on these assumptions, an equilibrium concentration of the fission products in the atmosphere above the sodium pool was calculated. Since the highest total amount of any isotope in the gas phase was less than 0.01 percent of the inventory in the sodium, it was assumed that this concentration remained constant for the duration of the accident except for radioactive decay. No credit was taken for plateout or leakout since these atoms would be replaced by atoms diffusing from the pool to maintain the equilibrium concentration as long as the inventory in the pool was not significantly decreased. Clean up factors in the heat transport system cells and RCB due to fallout or plateout were calculated with the HAA-3 computer code.

The pressure in the RCB was assumed to be 0.5 psig for the duration of the accident due to heat up and barometric pressure changes. No direct source of pressurization of the RCB was identified. The leakage from the heat transport system cells to the RCB was estimated to be 100%/day based on its functional design requirements to contain inert gas and the fact that slow heat up is the only identified pressurizing mechanism.

1.3.4 OFF-SITE RADIOLOGICAL CONSEQUENCES

The source terms discussed in Section 1.3.2 for the nominal TOP-HCDA and in Section 1.3.3 for the nominal LOF-HCDA were used in conjunction with the leak paths discussed in Section 1.3.1 to calculate radiological releases from the Reactor Containment Building.

The radiological consequences were analyzed with the COMRADEX computer code.(8) Atmospheric diffusion of radioactivity released to the environment was based on the 50 percent probability dispersion factors (χ/Q's). These values represent median atmospheric dilution conditions; dilution will be poorer (less dispersion) 50 percent of the time and better (more dispersion) 50 percent of the time. Table 7.1-1 of the ER lists the specific 50 percent χ/Q values as a function of downwind distance from the plant.

The results of the radiological analyses are presented in Tables B-5 through B-8. For each case analyzed, individual exposure doses are presented at seven distances of interest as follows:

1) 0.4 miles, site boundary
2) 0.6 miles, nearest residence
3) 1 mile, nearest recreational area
4) 4 miles, nearest dairy
5) 7 miles, nearest population center >2500 (Kingston)
6) 21 miles, nearest population center >100,000 (Knoxville)
7) 50 miles

Individual doses are presented for exposure times of 8 hours, 30 days, and the duration of the accident. In computing these doses it is assumed that an individual is continuously exposed at the downwind distance of interest from the start of the postulated accident up to the exposure time indicated.

The whole body population dose (man-rem) is determined by weighting the average annual wind frequency for each of sixteen 22.5 degree azimuthal sectors and the population per radial increment in each of these sectors. The population distribution used is the projected distribution for census year 2010, within 50 miles of the plant. The population dose per radial increment is the product of the population in the increment, the dose at the midpoint of the increment, and the annual wind frequency within the increment. The population doses per radial increment are based on sector centerline doses and thus are conservative since meandering of the wind within the sector is neglected. The total man-rem exposure per event is determined by a summation over all radial increments and azimuthal sectors.

The nominal TOP-HCDA results for both the Reference and Parallel Designs are presented in Table B-5. The potential off-site radiological consequences are insignificant since no failure of the primary coolant boundary is expected and the release is limited to a fraction of the radioactive noble gases. The only exposures resulting from this case are whole body and skin beta doses since there is no release of radioisotopes leading to bone, lung, or thyroid exposures. The highest whole body dose is 0.00015 Rem at 0.4 miles, the nearest site boundary. This dose includes the contribution of direct gamma shine from the RCB, cloud submersion, and inhalation. The major portion of this dose at the site boundary results primarily from direct gamma shine from the containment building. At greater distances, the direct dose contributes a smaller part of the total dose.

The results of the LOF-HCDA case which is assumed to be contained within the reactor vessel (without a Sealed Head Access Area) are presented in Table B-6. The maximum whole body gamma dose at the nearest site boundary, assuming continuous exposure for the duration of the accident, is about 0.007 Rem. This dose is due almost entirely to the direct shine dose. The maximum bone dose at 0.4 miles is 0.007 Rem, assuming continuous exposure for the duration of the accident. All other organ doses are at least a factor of 10 less than the bone exposure.

Another LOF-HCDA case considers the effect of a vessel melt-through for a plant design which includes a Sealed Head Access Area and an Ex-Vessel Core Catcher. The results of the radiological analysis for this case are presented in Table B-7. The integrated whole body dose at the site boundary, 0.4 miles, is 18 Rem. The integrated bone and lung doses at

0.4 miles are 3 and 22 Rem, respectively. These doses result only if an individual is continuously exposed at 0.4 miles for the duration of the release (a few months).

The doses in Table B-6 result entirely from the source term defined in Section 1.3.3.1, LOF-HCDA without melt-through. In view of the extremely low doses in this case, it can be concluded that large uncertainties in the source term to the cover gas can be accommodated with no substantial effect on the conclusion that there is no significant environmental impact. In the LOF-HCDA case with vessel melt-through, it is clear that the radiological consequences are controlled by releases into the reactor cavity, and the releases through the head are inconsequential.

Table B-8 summarizes the whole body population dose (man-rem) for each of the cases evaluated. The procedure for computing population exposure was discussed previously. The population exposures resulting from any of the cases evaluated are insignificant when compared to the natural background exposure within 50 miles of the plant, estimated to be 74,800 man-rem/year (See Section 5.3.2 of the ER).

1.4 SUMMARY AND CONCLUSIONS

Hypothetical core disruptive accidents have not been used as design basis accidents in the CRBRP Reference Design since the Project is designing the plant to prevent this class of accident. The reliability programs that are in progress will confirm the HCDA to be in the Class 9 category, thus removing the environmental effects from consideration under Appendix D to 10 CFR 50. However, since this position has not yet been fully supported, a Parallel Design which will consider HCDAs in the plant design basis is being developed. This Appendix to the Environmental Report addresses the environmental consequences of HCDAs.

The HCDAs are represented by two classes of events: Transient Overpower (TOP) and Loss-of-Flow (LOF). In each case, complete failure of the redundant shutdown systems concurrent with the initial transients is hypothesized in order to cause a disruptive event. The nominal consequences of each class of HCDA were analyzed in keeping with the intent of the accident analysis in the Environmental Report.

The best estimate of the consequences of the HCDAs is that they would not be energetic. In the case of a TOP-HCDA, the fuel damage is expected to be limited to a small part of the core and the materials would be cooled within the reactor vessel. Only minor leakage of noble gases would be expected in this case. For the LOF-HCDA, if it is contained within the reactor vessel, the releases of radioactive materials would also be minor. It is the Project intent to enhance the post accident heat removal capability of the core support structure. However, if the LOF-HCDA is not contained within the reactor vessel, the core materials would be contained in an ex-vessel core catcher. The potential releases of radioactive materials for this case are somewhat greater than the other cases, but still would not produce any substantial environmental impact.

The integrated population doses within a 50-mile radius of the plant were calculated. For the duration of the postulated releases, the integrated population doses ranged from 0.002 to 611 man-rem. Even in the case of the greatest release, the integrated population exposure is less than 1 percent of natural background exposure.

TABLE B-1

CHRONOLOGY* OF EVENTS IN REACTIVITY INSERTION HCDA
NOMINAL CASE

Time (sec)	Event
0.0	Reactor at steady state rated operation, 975 MW $3.20 insertion at 10¢/sec initiated.
8.55	Fuel in peak power channel cracks under internal pressure and contacts cladding. Core power at 2.25 times rated.
12.84	Peak channel (6% of core fuel) fails due to internal pressures, in upper quarter of axial height. Fuel-sodium interaction initiated. Core power at 4 times rated. Midplane fuel melt fraction of 0.5.
12.86	Lower boundary of fuel-coolant interaction zone reaches core midplane.
12.87	Peak core power (27 times rated) and net reactivity attained.
12.89	Reactor goes subcritical by fuel disposal from expansion of the fuel-coolant interaction zone, fuel ejection from fuel pins almost over.
12.95	Liquid sodium starts to re-enter failed channel from inlet.
12.99	FCI zone collapses as liquid sodium re-establishes flow with some boiling.

*Predicted by SAS computer code and engineering judgment.

TABLE B-2

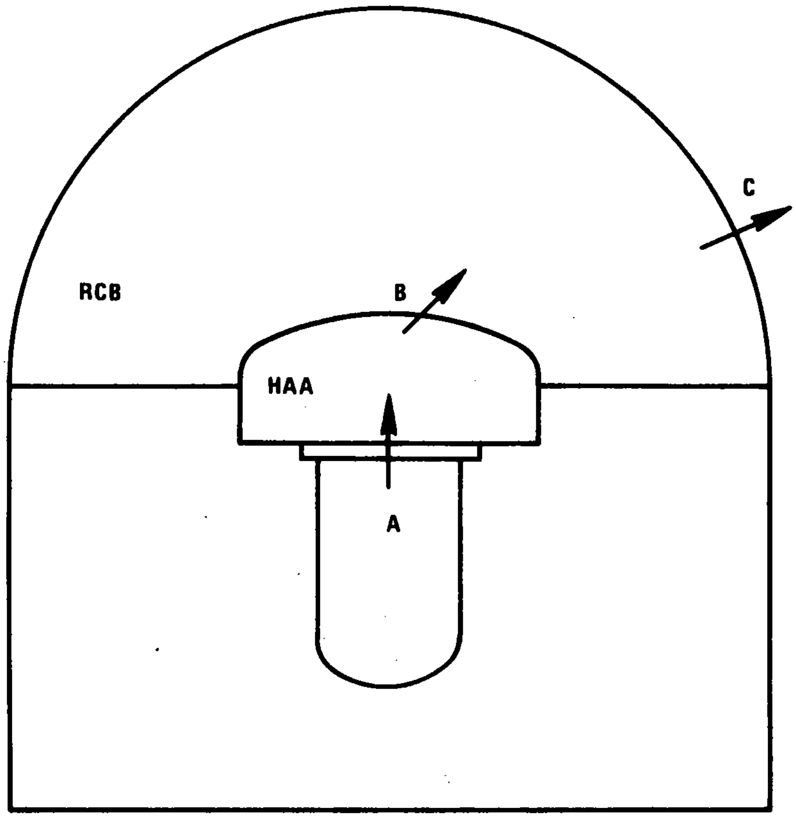
CHRONOLOGY* OF EVENTS IN NOMINAL LOSS OF FLOW HCDA ANALYSIS

Time (sec)	
0.0	Reactor at steady state rated power (975 MW) Begin flow coastdown.
14.0	Initiate boiling in peak fuel subassembly.
14.8	Clad sodium film dryout in peak channels.
14.05 to 16.05	Initiate boiling in remainder of core and clad melting in peak fuel subassembly.
Beyond 16.05	Gross fuel melting and fuel rod failures occur throughout the reactor core. Possible excursion, clad boiling and fuel melting disperse the core into a non-critical configuration. Following continued permanent dispersion, the debris will either be cooled in vessel or will melt through to an ex-vessel core catcher after a few hours.

*Predicted by SAS computer code and engineering judgment.

TABLE B-3

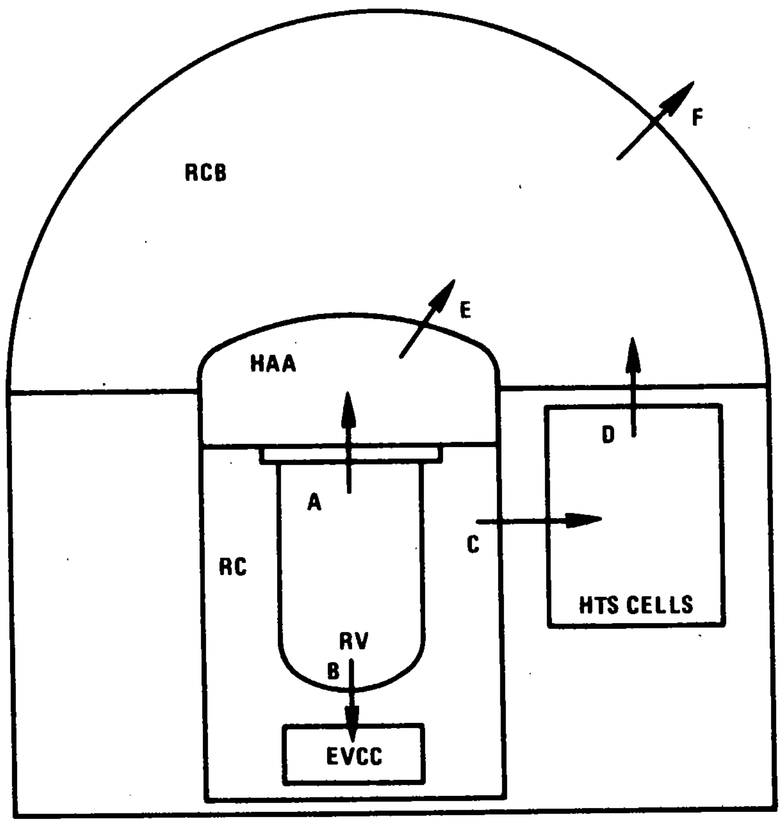
LEAKAGE CONDITIONS FOR TOP HCDA ANALYSES



CASE	LEAK PATH	INITIAL PRESSURE	LEAK RATE
TOP REFERENCE DESIGN	A	1.0 psig	4.4×10^{-11}/Sec (0.012 scc/Min = 3.0 psig)
	B	–	∞ (Open HAA)
	C	0.5 psig	2.6×10^{-9}/Sec (0.1% Vol/Day @ 10 psig)
TOP PARALLEL DESIGN	A	1.0 psig	0.04 scc /Min (4.4×10^{-11}/Sec)
	B	10 psig	6.1×10^{-6}/Sec (Decreasing) (100% Vol/Day @ 35 psig)
	C	0.5 psig	2.6×10^{-9}/Sec (0.1% Vol/Day @ 10 psig)

TABLE B-4

LEAKAGE CONDITIONS FOR LOF HCDA ANALYSES



CASE	LEAK PATH	INITIAL PRESSURE	LEAK RATE
LOF CONTAINED IN REACTOR VESSEL	A	11.9 psig	6×10^{-10}/Sec (0.012 scc/Min @ 0.3 psig)
	B	–	0
	C	–	–
	D	–	–
	E	–	∞ (Open HAA)
	F	0.5 psig	2.6×10^{-9}/Sec (0.1% Vol/Day @ 10 psig)
LOF WITH VESSEL MELT-THROUGH	A	11.9 psig	6×10^{-10}/Sec (0.012 scc/Min @ 0.3 psig)
	B	–	∞
	C	35 psig	100% VOL/DAY (Decreasing)
	D	–	100% VOL/DAY
	E	10 psig	6.1×10^{-6}/Sec (Decreasing) (100% Vol/Day @ 35 psig)
	F	0.5 psig	2.6×10^{-9}/Sec (0.1% Vol/Day @ 10 psig)

TABLE B-5

INTEGRATED RADIOLOGICAL DOSES FROM NOMINAL TOP-HCDA (Reference Design)

Continuous Exposure Time	Whole Body Dose (rem)			Skin Beta Dose (rem)		
	8 hr	30 d	Infinite	8 hr	30 d	Infinite
DISTANCE						
0.4	6.71-07*	1.13-04	1.46-04	1.96-09	1.64-06	3.87-06
0.6	5.58-08	1.01-05	1.32-05	1.31-09	8.56-07	2.03-06
1.0	1.02-09	1.21-07	2.61-07	7.40-10	3.80-07	8.98-07
4.0	1.38-10	2.96-08	3.80-08	1.31-10	4.95-08	1.17-07
7.0	7.07-11	1.60-08	2.02-08	6.40-11	2.20-08	5.20-08
21.0	9.84-12	3.69-09	4.76-09	1.57-11	5.40-09	1.28-08
50.0	1.43-12	8.44-10	1.09-09	5.31-12	1.83-09	4.31-09
Parallel Design Case						
0.4	3.03-08	3.69-05	4.95-05	9.51-11	5.38-07	1.37-06
0.6	2.63-09	3.11-06	4.18-06	6.38-11	2.80-07	7.13-07
1.0	4.45-11	5.83-08	7.33-08	3.60-11	1.24-07	3.18-07
4.0	6.60-12	9.80-09	1.28-08	6.37-12	1.62-08	4.13-08
7.0	3.40-12	5.29-09	6.93-09	3.11-12	7.20-09	1.84-08
21.0	5.40-13	1.23-09	1.62-09	7.62-13	1.77-09	4.51-09
50.0	7.13-14	2.82-10	3.73-10	2.58-13	5.98-10	1.53-09

*6.71-07 = 6.71×10^{-7}

TABLE B-6

INTEGRATED RADIOLOGICAL DOSES FROM AN LOF-HCDA CONTAINED WITHIN THE REACTOR VESSEL (Open Head Access Area)

Distance Miles	Continuous Exposure Time	Dose (rem) Bone	Thyroid	Lung	Whole Body	Beta Skin
0.4	8 hrs	2.78-06*	3.53-07	1.38-07	4.35-05	4.76-07
0.6	8 hrs	1.84-06	2.31-07	9.11-08	3.65-06	3.18-07
1.0	8 hrs	1.04-06	1.31-07	5.16-08	6.41-08	1.80-07
4.0	8 hrs	1.99-07	2.42-08	1.14-08	8.87-09	3.18-08
7.0	8 hrs	1.02-07	1.21-08	5.04-09	4.38-09	1.56-08
21.0	8 hrs	2.67-08	2.87-09	1.31-09	6.29-10	3.78-09
50.0	8 hrs	9.80-09	9.07-10	4.73-10	8.20-11	1.28-09
0.4	30 days	8.62-04	2.38-05	3.82-05	5.98-03	2.98-04
0.6	30 days	4.38-04	1.22-05	1.95-05	5.06-04	1.56-04
1.0	30 days	1.90-04	5.28-06	8.40-06	1.07-05	6.41-05
4.0	30 days	2.69-05	7.47-07	1.19-06	1.58-06	2.59-05
7.0	30 days	1.30-05	3.58-07	5.73-07	8.56-07	1.07-05
21.0	30 days	3.27-06	8.80-08	1.44-07	1.96-07	9.82-07
50.0	30 days	1.91-06	3.04-08	5.27-08	4.47-08	3.33-07
0.4	Infinite	7.07-03	2.58-05	2.62-04	6.98-03	3.67-04
0.6	Infinite	3.62-03	1.32-05	1.34-04	5.91-04	1.86-04
1.0	Infinite	1.55-03	5.71-06	5.76-05	1.29-05	8.51-05
4.0	Infinite	2.02-04	8.07-07	8.11-06	1.90-06	1.11-05
7.0	Infinite	1.06-04	3.89-08	3.91-06	1.03-06	4.91-05
21.0	Infinite	2.67-05	9.53-09	9.87-07	2.36-07	1.21-06
50.0	Infinite	9.76-06	3.20-09	3.60-07	5.51-08	4.09-07

*2.78-06 = 2.78×10^{-6}

TABLE B-7

INTEGRATED RADIOLOGICAL DOSES FROM AN LOF-HCDA
FOR ASSUMED VESSEL MELTTHROUGH PARALLEL DESIGN CASE
(Sealed Head Access Area and Ex-Vessel Core Catcher)

Distance Miles	Continuous Exposure Time	Dose (rem) Bone	Thyroid	Lung	Whole Body	Beta Skin
0.4	8 hrs	1.25-07*	3.87-06	1.01-06	7.01-02	7.78-04
0.6	8 hrs	9.40-08	2.53-06	5.16-07	2.67-03	5.16-04
1.0	8 hrs	5.40-08	1.41-06	2.64-07	4.33-04	2.89-04
4.0	8 hrs	1.03-08	2.38-07	4.98-08	1.48-05	5.04-05
7.0	8 hrs	5.30-09	1.08-07	2.53-08	7.51-06	2.44-05
21.0	8 hrs	1.37-09	1.68-08	6.44-09	1.12-06	5.91-06
50.0	8 hrs	5.00-10	2.71-09	2.29-09	1.43-07	1.98-06
0.4	30 days	2.03-01	2.20-01	1.41	1.44+01	7.42-01
0.6	30 days	1.01-01	1.14-01	7.18-01	1.26	5.36-01
1.0	30 days	4.44-02	4.89-02	3.09-01	1.30-01	1.73-01
4.0	30 days	6.28-03	6.89-03	4.36-02	7.33-03	2.20-02
7.0	30 days	3.02-03	3.33-03	2.11-02	3.78-03	9.78-03
21.0	30 days	7.62-04	8.22-04	5.33-03	8.96-04	2.40-03
50.0	30 days	2.79-04	2.89-04	1.93-03	2.60-04	8.16-04
0.4	Infinite	3.02	2.64-01	2.14+01	1.80+01	1.12
0.6	Infinite	1.54	1.35-01	1.09+01	2.25	9.02-01
1.0	Infinite	6.62-01	5.80-02	4.71	4.07-01	5.71-01
4.0	Infinite	9.33-01	8.22-03	6.62-01	5.64-02	6.70-02
7.0	Infinite	4.51-02	4.00-03	3.20-01	2.84-02	3.13-02
21.0	Infinite	1.13-02	9.56-04	8.00-02	6.89-03	7.56-03
50.0	Infinite	4.42-03	3.33-04	2.89-02	3.78-03	6.00-03

*1.25-07 = 1.25×10^{-7}

TABLE B-8

POPULATION DOSES FROM HCDA'S (INTEGRATED OVER A 50 MILE RADIUS)

TOP-HCDA

	Dose (Man-Rem)		
Exposure Time	8 Hour	30 Days	Infinite
Reference Design	1.1-06*	3.9-04	5.3-04
Parallel Design	6.9-08	1.4-04	1.9-04

LOF-HCDA

Reference Design Without Melt-Through	8.6-05	1.9-02	2.2-02
Parallel Design with Melt-Through	0.133	78.7	611

*1.1-06 = 1.1×10^{-6}

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